SM 112 Portable Dual Trace Oscilloscope

Part 2 Servicing Instructions

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SM112

SM 112
Portable
Dual Trace
Oscilloscope

Part 2
Servicing
Instructions

SM112

Instruction Manual

OSCILLOSCOPE SM 112

PART 2

SERVICING INSTRUCTIONS

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SECTION 1 - INTRODUCTION

This handbook forms Part 2 of a two-part Instruction Manual for the SM112 Portable Dual-Trace Oscilloscope. The complete manual comprises:

Part 1 - Operating Instructions

Part 2 - Servicing Instructions

Part 1 contains general information on the oscilloscope, its specifications, installation and setting-up procedures, and operating instructions for use. The time-base module SM602 and the Y-amplifier module SM599 are described under their relevant sub-headings within the various sections.

Part 2 contains the circuit descriptions, alignment procedures, maintenance and parts list for the oscilloscope main frame and the two plug-in modules. For ease of reference, each of these sub-units is dealt with, in its entirety, in a separate section of the handbook. In addition to this modular approach, the overall system is covered in sections dealing with system alignment procedures and system maintenance information.

To achieve high performance and long-term reliability with low-power consumption, silicon transistors and integrated circuits have been used throughout the oscilloscope. In general, printed-circuit boards have been used for circuit construction to combine compactness and ease of servicing.

The main frame of the oscilloscope contains a power unit, a calibrator, a blanking amplifier, a c.r.t. circuit, an X-output amplifier and a Y-output amplifier. For the purposes of this book, the sub-unit boards are coded as follows:

Power Supply Board	F1
Power Supply Board	F2
EHT Board	F3
Blanking Amplifier Board	F4
X-output Amplifier Board	F5
Y-output Amplifier Board	F6

For clarity, component references on the circuit diagrams are prefixed with the number of the sub-unit board on which the components are located. For example, 1R25 refers to resistor R25 on the power supply board F1. Components with no board reference prefix are mounted on the main assembly. The code prefixes do not appear on the actual silk screening of the units.

2.1 - CIRCUIT DESCRIPTION

1. GENERAL

The main frame of the SM112 Oscilloscope houses the c.r.t., the mains transformer and six printed-circuit boards which, for ease of cross-reference within the manual, have been coded as indicated in Section 1.

The interconnections of the main sub-assemblies are shown in Fig. 2.5, the Main Frame Block Schematic. For convenience, these sub-assemblies are described with reference to three circuit diagrams as follows:

(a) Power Supplies and CRT Circuit, Fig. 2.9.

(b) Y-output Amplifier, Fig. 2.11.

(c) X-output Amplifier, Fig. 2.13.

Block diagrams of these circuits have been included to indicate the overall circuit function and the relationship of the various circuit elements.

2. POWER SUPPLIES AND CRT CIRCUIT (FIG. 2.1 AND 2.9)

2.1 STABILISER CIRCUITS

The input line supply is connected to PLA and is routed via the two-pole SUPPLY switch SA, fuse FS1, and voltage selector switches SB and SC, to the primary windings of T1.

The output of T1 secondary winding (9,10,11) is full-wave rectified by 1D1-1D4 to produce unregulated d.c. supplies of nominally +12 V and -12 V with respect to earth.

Series stabilisation of the +12 V supply is achieved via TR2 which is controlled by a conventional stabilising circuit. The 120 V rectified supply, via 1R4, provides the pre-regulation base drive current for 1TR1 and the collector currents of 1TR3 and 1TR4. The SET +12 V control 1R13 forms part of a potential divider chain which controls the base potential of 1TR6. Any variation of the +12 V output is compared in the long-tailed pair 1TR5, 1TR6 with the reference voltage developed across the zener diode 1D9, and is passed via 1TR4 and 1TR1 to control the base of the series stabiliser TR2. Transistor 1TR3 and resistor 1R6 form a fold-back current-limiting circuit to prevent overload damage; similarly, the -12 V supply is stabilised via the series stabiliser 1TR8 controlled by the long-tailed pair 1TR11, 1TR12 and 1TR9. The -12 V supply fold-back current-limiting circuit is formed by 1TR7 and 1R15.

The -12 V unstabilised supply is used in conjunction with diodes 1D5 and 1D6 and capacitors 1C1 and 1C2 to form a voltage doubler circuit. The output from this doubler is applied to the zener diode - resistive network 1D22, 1D233, 1D10 to produce a stabilised -18 V output.

The output of the T1 secondary winding (13, 14, 15) is full-wave rectified by 2D13 - 2D16 to produce an unsmoothed d.c. supply of nominally +60 V. Diodes 2D41, 2D42, 2D17, 2D18, in conjunction with this unregulated +60 V supply form a voltage doubler circuit to produce the +120 V supply smoothed by 2C15. This +120 V supply provides the pre-regulation voltage for the stabiliser circuit of the +60 V supply.

Any tendency for the +60 V output to vary is sensed via the potential divider 2R36, 2R37, at the base of 2TR21. The resulting output is compared with the +12 V reference at the emitter of 2TR20 to control the base of 2TR17 and, hence, the series stabiliser TR18. The fold-back limiter network comprising 2TR19, 2R33, 2R215, 2R216, and 2R217 reduces the short-circuit current through the series stabiliser to approximately 250 mA.

The +30 V stabiliser circuit is taken from the secondary winding centre-tap (14). Transistor 2TR16 and resistor 2R133 provide a limiting circuit for the current through the series stabiliser TR15.

The +5 V supply is derived from the +12 V stabilised rail via transistor 1TR14, controlled by 1TR13.

Control of the four graticule lamps is achieved by the GRAT potentiometer R40, between 0 V and the -12 V rail, in the base circuit of TR22.

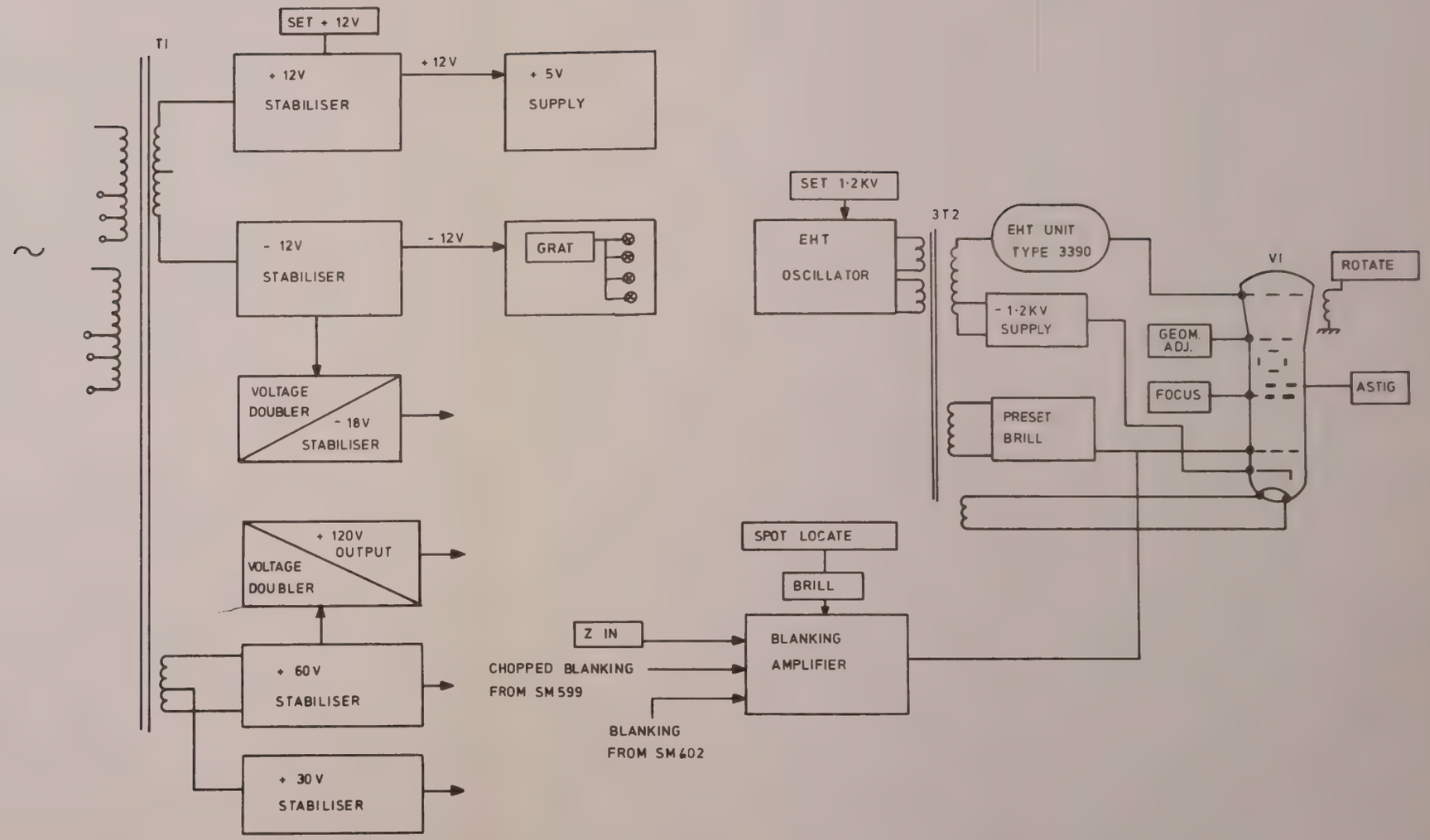
The e.h.t. circuit comprises a d.c.-to-d.c. converter which also provides the other supply voltages for the c.r.t. Transistor TR25 in conjunction with the primary windings of 3T2 forms a blocking oscillator having a frequency of 20 kHz. The drive to the blocking oscillator is adjusted by the SET 1.2 kV control via transistors 3TR33 and 3TR24. The main secondary winding of 3T2 provides the output for the e.h.t. quadrupler unit, type 3390, which supplies 11 kV for the post-deflection anode of the c.r.t.

2.2 C.R.T. CIRCUIT

A tapping on the e.h.t. winding of 3T2 provides an output, which after rectification by 3D24 and subsequent smoothing in the R-C network 3C23, 3R47, 3C24 and 3C25, supplies the c.r.t. cathode potential of -1200 V.

The c.r.t. heater is supplied from a separate winding of 3T2 and is connected to the c.r.t. cathode supply.

The potential for the control grid of the c.r.t. is supplied via rectifier 3D25



POWER SUPPLIES AND CRT CIRCUIT

BLOCK DIAGRAM

(MAIN FRAME SM 112)

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FIG. 2.1.

from another secondary winding of 3T2. The c.r.t. beam current is initially set by the PRESET BRILL control, 3R49, which is in series with the rectified output.

The FOCUS potentiometer, R59, is part of a potential divider chain connected between -1200 V and a potential that can be varied positively from 0 V dependent on the position of the 'Geometry Adjust' control, 4R54. The FOCUS potentiometer is adjusted in conjunction with the ASTIG control R62 to achieve optimum beam spot size and shape on the screen.

The trace ROTATE potentiometer, R61, interposed between the +12 V and -12 V rails, determines the amplitude and direction of the current flow throughout the coil connected across PLB and permits the c.r.t. trace to be axially aligned with the graticule.

2.3 BLANKING AMPLIFIER

The blanking amplifier comprises transistor 4TR26 in grounded-base configuration followed by emitter-follower 4TR27 driving the complementary pair, 4TR29, 4TR30.

The current in 4TR26 is controlled by the BRILL control, R63, in the emitter circuit. This control is short-circuited when the SPOT LOCATE push-button is operated so that maximum intensity is obtained to facilitate location.

Three inputs to the blanking amplifier are provided:

Z IN - a rear-panel socket (SKA) input for Z modulation.

Blanking input from Y amplifier (used in 'chop' mode) - on SKB pin 15 from the SM599 unit.

Flyback blanking from X amplifier - on SKC pin 15 from the SM602 unit.

The output pulses of the blanking amplifier feed the c.r.t. control grid via 4R78, and the capacitor 3C28 shunted by 3R51.

2.4 MODULE CONNECTIONS

Connections to the two plug-in modules are effected by two 16-way McMurdo sockets located at the rear of the module compartment.

Sockets SKB and SKC provide the connection for the Y-amplifier module and the X-amplifier module respectively. Each socket routes the respective signals to the output amplifiers in the main frame, accepts blanking input signals and provides interconnections between the two modules. The sockets also feed the necessary power supplies to the modules. In addition, SKC (pin 13) routes a potential from the CONTRAST control R187 to the B-sweep board in the X-amplifier module.

3. Y-OUTPUT AMPLIFIER (FIG. 2.2 AND 2.11)

The signals from the Y-amplifier are routed to the balanced input of the Y-output amplifier via delay line DL1. This introduces a delay of 160 ns to enable the leading edge of the pulse from which the sweep is derived to be displayed when the internal trigger mode is selected. A block diagram is shown in Fig. 2.2.

Transistors 6TR31, 6TR33 and 6TR34, 6TR35 form a balanced series-shunt feedback stage which is frequency compensated by the adjustment of emitter circuit components 6C72 and 6R198. Transistor 6TR32 which carries the emitter current of 6TR34 and 6TR35 is normally fully conducting.

When the SPOT LOCATE push-button is operated a negative input from SD-a switches off 6TR32, thus limiting the output swing of the Y-output amplifier.

The output amplifier stage 6TR36, 6TR37, 6TR38 and 6TR53 is also of the series-shunt feedback type. High-frequency compensation is provided by trimmer capacitors 6C37, 6C38. The preset 6R99, SET M.P.P. permits the mean plate potential to be set during alignment. It determines the d.c. operating point for the output stage.

The diode coupling to the output transistors 6TR38, 6TR53, constitutes a voltage shift network. Diodes 6D49 and 6D50 form a feedback clamp to prevent 6TR38, 6TR53 fully conducting.

Outputs to the Y1 and Y2 plates of the c.r.t. are taken from the collectors of output transistors 6TR38 and 6TR53 respectively via the r.f. chokes L1 and L2.

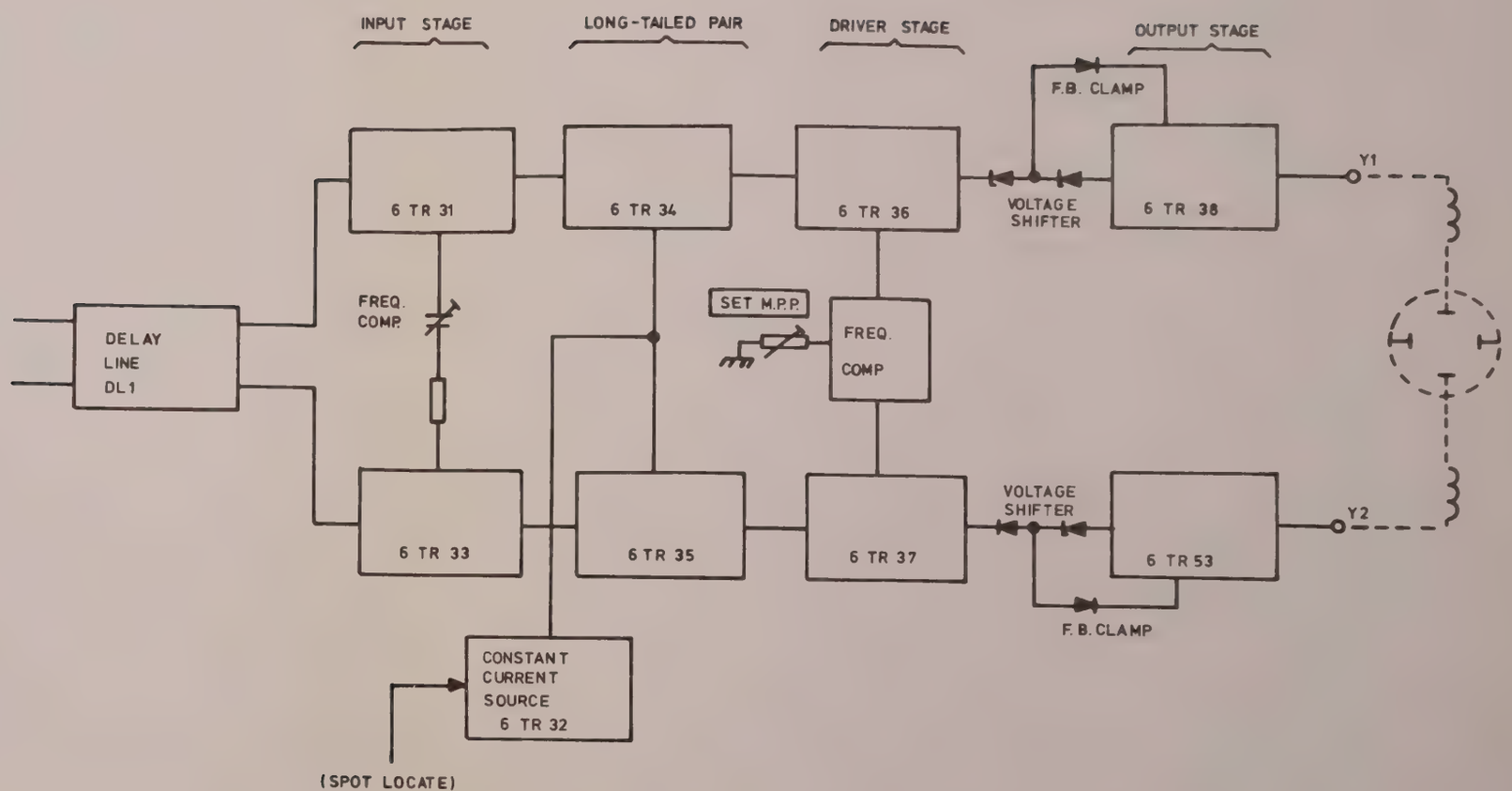
4. X-OUTPUT AMPLIFIER (FIG. 2.3 AND 2.13)

The input to the X-output amplifier accepts timebase signals either from the X-timebase module SM602 or from an external source (X IN) depending on the position of the mode switch SF.

Signal inputs are routed to the field-effect transistor, 5TR42, which provides a high-impedance buffer stage, the source being direct-coupled to the emitter follower 5TR44.

Transistors 5TR45, 5TR28 form a current-driven phase splitter, resistor 5R144 determining the signal current, and resistors 5R145, 5R152, in conjunction with the shift potentiometers, the coarse and fine shift currents respectively.

For the purpose of gain calculations, the subsequent stages of the amplifier can be regarded as a composite section. In the x1 mode, the gain is controlled by the network 5R149, 5R148 (GAIN x1), in conjunction with the feedback resistors 5R165 and 5R171. In the x10 mode, the gain is controlled by the R-C network, switched by SG, which incorporates the GAIN x10 control 5R146, also in conjunction with 5R165 and 5R171.



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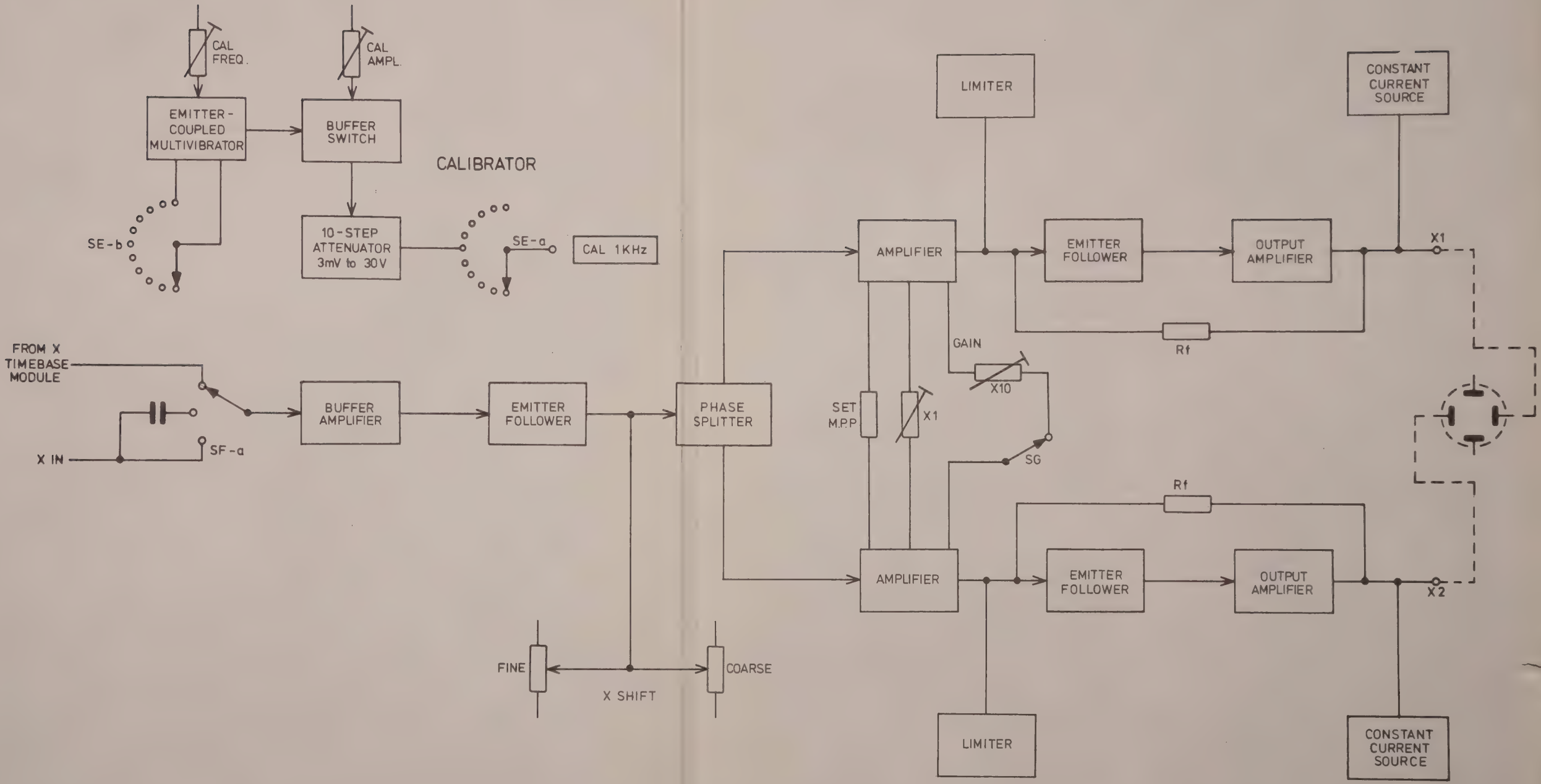
Y-OUTPUT AMPLIFIER
BLOCK DIAGRAM
(MAIN FRAME SM112)

FIG. 2.2



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X-OUTPUT AMPLIFIER AND CALIBRATOR BLOCK DIAGRAM

FIG. 2.3

Reverse-connected diodes limit the drive to emitter followers 5TR47, 5TR50. These are direct-coupled to provide a low-impedance drive to the output transistors 5TR49 and 5TR52, the collectors of which feed the X1 and X2 plates of the c.r.t. respectively.

Considering the X1 output stage, the collector d.c. supply for 5TR49 is drawn via the constant-current load formed by 5TR48. The decoupling capacitor 5C58 and the coupling capacitor 5C57 serve to increase the a.c. signal output swing as 5TR49 is turned on.

The operation of the X2 output stage is identical to that of the X1 output stage described above.

5. CALIBRATOR (FIG. 2.13)

The voltage calibrator consists of an emitter-coupled multi-vibrator oscillator, 1TR39 and 1TR40, producing a square-wave output at a frequency of 1 kHz, set by the CAL FREQ preset 1R113.

Transistor 1TR41 provides a switching stage, the output of which is controlled by the emitter preset 1R119 (CAL AMPL). A ten-step attenuator controlled by SE-a provides square-wave outputs for calibration purposes from 3 mV to 30 V.

An additional facility, provided in position 10, is a 30 V d.c. calibration output. In this position, the auxiliary contact SE-b switches off the oscillator transistor 1TR39 so that 1TR40 turns on the amplifier transistor 1TR41. The emitter-collector chain forms a potential divider to produce 30 V d.c. at the CAL output socket.

1. TEST EQUIPMENT

(a) A.C. and d.c. multimeter, sensitivity 20,000 Ω per volt (an Avometer Model 8 is suitable).

(b) Digital Voltmeter, d.c. 1 V to 1 kV (such as SE LABS SM210, 211, 212 series) (and a 10 MΩ, ± 1%, resistor for range extension).

(c) Mains Variac, 100 W minimum, outputs 80 V to 270 V.

(d) Electrostatic voltmeter, full-scale-deflection of 12 kV.

(e) Oscilloscope calibrator (a Bradley 156 is suitable).

(f) Dummy load comprising a connector to mate with the Y-amplifier socket (SKT B) within the main frame, wired as shown in Fig. 2.4.

Plug Pin No.		Connections
1		N.C.
2		N.C.
3		
4		
5		
6		
7		
8		N.C.
9		N.C.
10	(EARTH)	
11		N.C.
12		
13		
14		
15		
16		N.C.

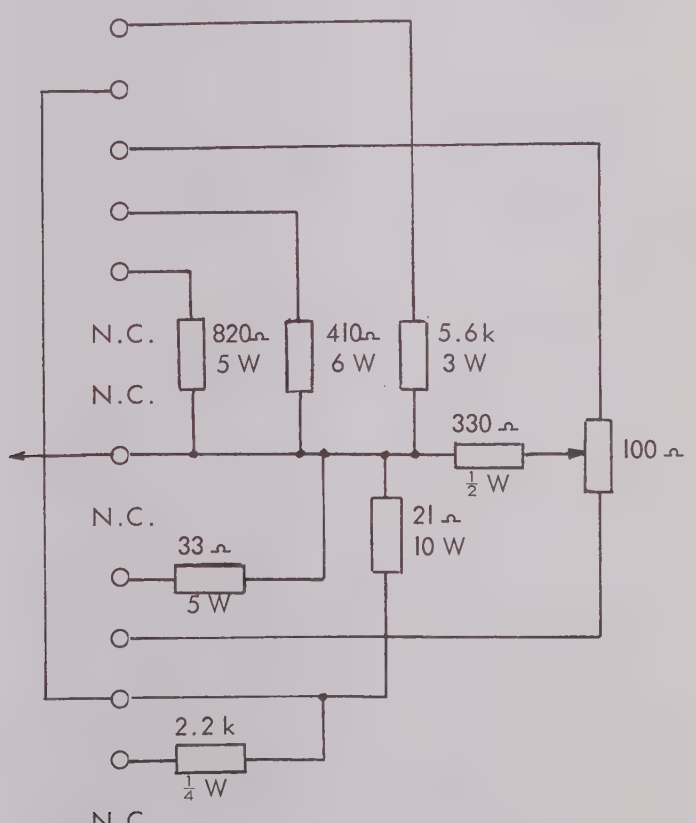

FIG. 2.4 DUMMY LOAD

(g) Jumper lead terminated with pin sockets (to fit 1 mm pins) length 6 in.(approx.).

(h) Oscilloscope (double beam). An SE LABORATORIES EM102, fitted with EM530 Y-amplifier module.

2. PRELIMINARY SETTINGS

(a) Remove both plug-in modules from the main frame.

(b) Remove fuse FS2 from the e.h.t. p.c. board (3).

(c) Set the following controls on p.c. board 3 fully anti-clockwise:

(i) 'Set 1.2 kV' (3R41) on p.c. board 3.

(ii) 'Preset Brill' (3R49) on p.c. board 3.

(iii) 'Set +12 V' (1R13) on p.c. board 3.

(d) Connect the dummy load into SKT B (Y-amplifier).

(e) Set the front panel controls:

(i) BRILL (R63) fully anti-clockwise.

(ii) COARSE X-shift (R156) to mid-position.

(iii) CAL 1 kHz Selector to 30 V DC.

(iv) SWEEP; AC:DC Selector to EXT DC.

(v) PULL x 10 pushed-in (x 1 gain setting).

(vi) ROTATE to mid-position.

3. LOW-VOLTAGE POWER SUPPLY - ADJUSTMENTS AND CHECKS

(a) Select 220 V mains voltage operation on the rear panel (using the SUPPLY VOLTS selectors).

(b) Connect the dummy load into the Y-amplifier mating socket on the main frame (in place of a Y-amplifier Module).

(c) Connect the digital voltmeter to pin 3 on p.c. board 1 (and chassis).

(d) Connect the rear panel SUPPLY ~ socket to the output of the Variac (set to 0 V). Set the GRAT/SUPPLY ON switch to ON (check that the ON indicator lights up).

(e) Adjust the 'Set 12 V' control (1R13) for a reading of +11.99 V to 12.01 V.

(f) Check the following supplies; between the pin number listed and chassis:

P.C. Board No.	Pin No.	Voltage
1	13	-11.7 V to -12.3 V
1	15	-17.5 V to -18.5 V
1	14	+4.7 V to +5.3 V
2	32	+115 V to +125 V
2	25	+58.5 V to +61.5 V
2	23	+29 V to +31 V

4. CALIBRATOR D.C. OUTPUT AMPLITUDE ADJUSTMENT

(a) Connect the digital voltmeter to the CAL 1 kHz output socket.

(b) Adjust 'CAL Ampl' (1R119) to obtain a reading of between 29.9 V and 30.1 V.

5. C.R.T. CATHODE VOLTAGE SETTING

(a) Switch-off the Main Frame SM112 (GRAT/SUPPLY ON fully anti-clockwise).

(b) Connect the multimeter (1A DC Range) across fuseholder FS2 on the e.h.t. p.c. board (3). Connect the digital voltmeter, with a 10 MΩ series resistor, between pin 54 (on e.h.t. board 3) and chassis.

(c) Switch-on the Main Frame SM112. The current (AVO 8) should peak at the instant of switch-on and should fall to 300 mA (approx.) within 30 seconds.

(d) Adjust 'Set 1.2 kV' (3R41) for a reading on the digital voltmeter of between 597 V and 603 V.

(e) Check that no spot is visible on the c.r.t. screen.

(f) Record the current reading on the multimeter.

(g) Switch-off the Main Frame SM112, disconnect both meters, and fit fuse FS2 to the e.h.t. p.c. board (3).

6. CALIBRATOR SWITCHED OUTPUT AMPLITUDE CHECK

(a) Connect the jumper lead between pins 3 and 17 on p.c. board 1.

(b) Connect the digital voltmeter to the CAL 1 kHz output connector and set the CAL 1 kHz selector to 3 mV.

(c) Switch-on and check that the output, against each switch position, is within the limits stated below:

Switch Position	Output Limits
3 mV	2.97 mV to 3.03 mV
10 mV	9.9 mV to 10.1 mV
30 mV	29.7 mV to 30.3 mV
100 mV	99 mV to 101 mV
300 mV	297 mV to 303 mV
1 V	0.99 V to 1.01 V
3 V	2.97 V to 3.03 V
10 V	9.9 V to 10.1 V

(d) Switch-off and remove jumper lead.

7. EHT VOLTAGE CHECK

(a) Connect the electrostatic voltmeter between the A4 connection on the c.r.t. and chassis (with the e.h.t. lead connected).

BEWARE: HIGH VOLTAGES ARE PRESENT.

(b) Switch-on and check that the e.h.t. voltage is between 10.5 kV and 11.5 kV. Switch-off and disconnect the meter.

8. PRESET BRILLIANCE ADJUSTMENT

(a) Rotate the BRILL control (R63) approximately 10 degrees from its maximum anti-clockwise position.

(b) Rotate the 'Preset Brill' (3R49) slowly clockwise until a spot is visible on the screen. Adjust the FOCUS (R59) and ASTIG (R62) to obtain the best spot.

9. C.R.T. X-ALIGNMENT

(a) Connect the digital voltmeter between pins 94 and 95 on p.c. board 5.

(b) Adjust the COARSE and FINE X controls to obtain a reading of less than ± 1 V. Check that the spot is within ± 0.5 cm of the X graticule line.

10. C.R.T. X1/X2 PLATES - MEAN POTENTIAL ADJUSTMENT

(a) Connect the digital voltmeter between pin 95 and chassis.

(b) Adjust the 'Set M.P.P.' potentiometer (5R186) to obtain a reading between 44 V and 46 V.

(c) Disconnect the digital voltmeter.

11. X GAIN (x1) ADJUSTMENT

(a) Position the spot to the extreme left-hand side of the graticule.

(b) Connect the test oscilloscope calibrator to the X IN socket, output set to 8 V squarewave.

(c) Adjust the 'Gain x 1' potentiometer (5R148) so that a second spot is positioned 9.5 cm, ± 0.1 cm away from the first spot.

12. ROTATE SETTING

(a) Adjust the front panel ROTATE control (R61) so that both spots (as set-up in 11 above) are positioned on the same horizontal line.

13. X A.C. INPUT COUPLING CHECK

(a) Connect the test oscilloscope calibrator to the X IN socket, output set to 0.8 V squarewave.

(b) Set the SWEEP:AC:DC Selector to EXT AC. Check that the two spots move approximately 5 cm to the left.

14. X GAIN (x10) ADJUSTMENT

(a) Connect the test oscilloscope calibrator to the X IN socket, output set to 0.8 V squarewave.

(b) Set the SWEEP:AC:DC coupling Selector to EXT AC.

(c) Operate the PULL x 10 switch (to select x 10 gain). Adjust the 'Gain x 10' potentiometer (5R146) until the two spots on the screen are 9.5 cm, ± 0.1 cm apart.

15. CALIBRATOR 1 kHz OUTPUT CHECK

(a) Set the PULL x 10 gain switch to x 1 gain (push-in).

(b) Connect the output of the internal calibrator, CAL 1 kHz socket, to the X IN socket. Set the SWEEP:AC:DC Coupling selector to EXT AC.

(c) Set the CAL 1 kHz selector to 3V. Check that two spots are displayed between 3.5 cm and 3.7 cm apart.

16. C.R.T. Y-ALIGNMENT

(a) Connect the digital voltmeter, set to the 100 V d.c. range and using 1 kΩ $\frac{1}{4}$ W resistors as limiters, between pins 110 and 111 on p.c. board 6.

(b) Adjust the 100 Ω potentiometer on the dummy load (see Fig. 2.4) for a reading of less than ± 1 V. Check that the spot is within ± 0.5 cm of the Y Graticule centre-line.

17. C.R.T. Y1/Y2 PLATES - MEAN POTENTIAL ADJUSTMENT

(a) Connect the digital voltmeter between pin 111 on p.c. board 6 and chassis.

(b) Adjust the 'Set M.P.P.' potentiometer (6R99) for a reading of between 32 V and 34 V.

(c) Disconnect the digital voltmeter.

18. Y-OUTPUT CHECK

(a) Rotate the 100 Ω potentiometer throughout its travel. This should produce a shift of greater than ± 4 cm.

19. GRATICULE ILLUMINATION

(a) Rotate the GRAT control (R40) and check that all four bulbs (1LP2-5) light up.

20. Z-MODULATION CHECK

(a) Connect the +5 V level on pin 4 (SKT C) to the Z IN connector on the rear panel and check that this extinguishes a fairly bright spot.

21. MAINS INPUT CHECKS

(a) Connect the digital voltmeter to pin 3 (+12 V output) on p.c. board 1.

(b) Adjust the mains Variac from 200 V to 250 V (with the Voltage Selector Switches set for 220 V), and check that the reading changes by less than 0.02 V.

(c) Connect the digital voltmeter across (chassis mounted) capacitor C3 (4000 μF). Adjust the mains Variac to obtain a reading of +17 V.

(d) Switch-off and change the 3-position 'fine' SUPPLY VOLTS mains selector (SC) to the 224 V - 276 V range. Switch-on and check that the digital voltmeter reads between +15.0 V and +15.6 V.

(e) Switch-off and change the 3-position 'fine' SUPPLY VOLTS mains selector (SL) to the 180 V - 220 V range. Switch-on and check that the digital voltmeter reads between +19.3 and +19.9 V.

(f) Switch-off and select the SUPPLY VOLTS 90 V - 138 V 'Coarse' range and the 102 V - 138 V 'fine' range. Adjust the Variac to 0 and switch on. Increase the Variac voltage for a reading of +17 V on the digital voltmeter (connected across C3). Check that the a.c. input (on the Variac) is between 108 V and 118 V.

(g) Switch off and return the SUPPLY VOLTS selectors to the appropriate setting compatible to the local supply.

22. LOW-VOLTAGE POWER SUPPLY PROTECTION CHECK

(a) Connect the multimeter (set to the 10 A range) across each low-voltage output line on board 1 and check that the short-circuit current is within the limits listed below:

	Pin No.	Voltage	Current Limits
Board 1	3	+12 V	1.0 A to 1.4 A
	13	-12 V	1.0 A to 1.4 A
	25	+60 V	0.5 A to 0.8 A
Board 2	23	+30 V	0.35 A to 0.65 A

WARNING: Potentially dangerous voltages of 11 kV and 1.2 kV are present within the oscilloscope in addition to the potentially lethal mains voltage. Care should be exercised during maintenance. Do not remove the covers unless the instrument is disconnected from the a.c. supply.

1. INTRODUCTION

This section contains information on the maintenance of the main frame which forms the basic module for the SM112 oscilloscope. Routine maintenance and cleaning should be carried out preferably before the alignment procedures already detailed. After replacement of components, recalibration of the associated circuits must be carried out in accordance with the procedures outlined.

2. ACCESSIBILITY (FIG. 2.6, 2.7, 2.8, 2.10)

Access to the main frame sub-assemblies can be obtained by the removal of the two covers. These are each retained by three captive press-and-turn fasteners.

Each of the six printed-circuit cards of the main frame is secured by a retaining screw which, on release, permits the card to be hinged outwards to provide further access to components. When re-positioning card 6 ensure that the two push-on connectors mate correctly with the Y-plate pins of the c.r.t.

After maintenance, ensure that all retaining screws are secured, all connectors are fully home and correctly orientated.

3. PREVENTIVE MAINTENANCE

A preventive maintenance routine includes cleaning, visual inspection and lubrication and, if performed periodically, can prevent breakdown. The frequency of maintenance is determined by the environment to which the oscilloscope is subjected and the ideal time for routine maintenance check is immediately preceding re-calibration.

3.1 CLEANING

Due to its heat-insulating effect on components, dust accumulation within the main frame reduces heat dissipation and can cause breakdown. In conditions of high humidity its electrical conductivity increases and high-voltage arcing may occur on or around components associated with the two e.h.t. supplies.

A dry, low-velocity air line is recommended for removing dust, a small brush being particularly useful for dislodging dirt in inaccessible places such as switch wafers and on or under front-panel controls.

Care should be taken when cleaning to avoid deformation of the earthing strips located in the module compartment.

3.2 VISUAL INSPECTION

Periodically inspect the main frame for mechanical defects (e.g. on rotary switches or support brackets), for broken connections, including the printed wiring on the circuit cards, and for evidence of overheated components.

The occasional use of an approved lubricant (one that does not affect electrical or mechanical characteristics) can help to maintain the reliability of moving parts (e.g. rotary switches and potentiometers). Do not over-lubricate. Panclimatic grease should be used to lubricate concentric shafts.

4. REMOVAL AND REPLACEMENT OF C.R.T. ASSEMBLY

CAUTION: BEFORE REMOVING THE C.R.T. ASSEMBLY THE ANODE CONNECTION SHOULD BE DISCHARGED TO CHASSIS BY MEANS OF A LONG-BLADED INSULATED SCREWDRIVER.

(a) Remove the X, Y deflection leads from the c.r.t.

(b) Disconnect the orthogonality and/or ROTATE coil, (PLB).

(c) Remove the plug-in sub-unit modules.

(d) Remove the two c.r.t. assembly retaining screws located on the underside of the c.r.t., one on each side of the centre runner (15 cm from front of oscilloscope).

(e) Remove the six retaining screws for the carrying handle and top bar: two securing it to the c.r.t screen and two at each extreme end of the top bar.

(f) After discharge, remove the c.r.t. anode cap.

(g) Apply gentle pressure to the graticule and, at the same time, lift the rear of the c.r.t. assembly upwards and outwards to gain sufficient space to remove the c.r.t. base. Lift the assembly clear of the oscilloscope.

(h) Fit the new c.r.t. assembly by reversing the above procedure.

5. REMOVING THE MAINS TRANSFORMER

(a) Remove the bottom support bar by removing the four countersunk screws at the extreme ends of the bar and the fixing screw in the module compartment partition.

(b) Unscrew the four 2 BA bolts securing the mains transformer to the rear panel.

(c) Unsolder the leads from the cableform. (Note that the connections to tags 1 to 8 on the right-hand-side of the transformer follow the resistance colour-code convention, i.e. brown 1, red 2, etc.).

6. REMOVAL OF FRONT PANEL CONTROLS

X Shift Control, Pull x 10, X Input Selector, Cal Control

These controls located on the right-hand-side of the front panel can be removed as follows:

(a) Slide Card 5 towards the rear of the two runners as far as the leads will allow.

(b) Unsolder the connections to the control to be replaced.

(c) Prise off the centre cap of the front panel knob.

(d) Unscrew the knob-retaining screw or hexagonal nut and remove the knob.

(e) Remove the large hexagonal securing nut and remove the component.

Supply:Grat, Astig, Focus, Rotate, Brill:Contrast, Spot Locate

These controls located on the left-hand-side of the front panel can be removed as follows:

(a) Remove the c.r.t. as detailed in Para. 4.

(b) Hinge out Card 6 and slide it towards the rear of the two runners as far as the leads will allow.

(c) Slacken the four screws clamping the two support brackets for the front-panel controls.

(d) Unsolder the connections to the control to be replaced. To remove controls located on the front bracket unsolder the links to the rear bracket and slide the bracket towards the rear of the side runners. Prise off the centre cap of the knob, unscrew the knob-retaining hexagonal nut and remove the knob.

(e) Remove the large hexagonal securing nut and remove the component.

1. INTRODUCTION

This section contains information for ordering replaceable parts. The tables provide the following information:

(a) Circuit Reference.

(b) Value, Tolerance and rating (where applicable).

(c) Manufacturer/Reference.

(d) SEL Part No.

Minor items, such as screws, nuts, etc., have not been included as they are not considered special to the equipment.

2. ORDERING INFORMATION

To order your replacement parts, address the order to your local agent or to S.E. LABORATORIES (ENGINEERING) LTD. SERVICE DEPARTMENT, NORTH FELTHAM TRADING ESTATE, FELTHAM, MIDDLESEX, ENGLAND.
Telephone No. 01-890-1166/5876.

Specify the following information for each part:

(a) Model and serial number of the equipment.

(b) SEL part number, and manufacturer's reference.

(c) Circuit reference.

(d) Description (i.e. Value, Tolerance and rating).

To order a part not listed, give the part number, description of the major assembly which is listed, and a complete description of the part required.

The assemblies are listed as follows:

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol ± %	Rating
		Sub-Assemblies			
	60573	Card 1			
	60575	Card 2			
	60577	Card 3			
	60579	Card 4			
	60581	Card 5			
	60583	Card 6			
	WS28746	EHT Unit			
		Capacitors, fixed(μF)			
C3	CS30952	Mullard C431/BR/F4000	4000		25V
C6	CS30952	Mullard C431/BR/F4000	4000		25V
C9	CS30944	Mullard C431/BR/H500	500		64V
C11	CS30948	Mullard C432/FR/J900	900		100V
C47	CS30167	TCC D753/9	0.1	20	600V
C75	CS	Mullard 017-15681	680	+500 -10	16V
C76	CS	Mullard 017-15681	680	+500 -10	16V
C77	CS30362	Erie 801/K800011	0.01	+80 -20	250V
		Resistors (Ω) Fixed			
R1	DS32512	Electrosil TR5	150k	2	
R123	DS33695	Welwyn 4034/Z	4k	½	¼ W
R124	DS33694	Welwyn 4034/Z	1.4k	½	¼ W
R125	DS33693	Welwyn 4034/Z	400	½	¼ W
R126	DS33692	Welwyn 4034/Z	140	½	¼ W
R127	DS33691	Welwyn 4034/Z	40	½	¼ W
R128	DS33690	Welwyn 4034/Z	14	½	¼ W
R129	DS33689	Welwyn 4034/Z	10	½	¼ W
R130	DS33689	Welwyn 4034/Z	10	½	¼ W
R131	DS33968	Welwyn 4034/Z	3.5	1	¼ W
R132	DS33969	Welwyn 4034/G	1.5	1	¼ W
R158	DS32131	Electrosil TR5	2.2k	2	-
R159	DS32131	Electrosil TR5	2.2k	2	-

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R202	DS7479	Electrosil TR5	1k	2	-
R211	DS7478	Electrosil TR5	12k	2	-
R227	DS33740	Mullard MR25	270	2	-
R228	DS33740	Mullard MR25	270	2	-
		Resistors Variable (Ω)			
R40 +SA	DS33816	AB Electronic AY-45 INV.LOG.	2.2k	20	-
R59	DS33815	Erie type 60 LIN.	2 M		
R61	DS33820	AB Electronic, type 'AB wound 1' LIN	2.2k	20	
R62	DS33821	AB Electronic, type 45 LIN	1 M	20	
R63	DS33814	AB Electronic, type C2-45 LIN	4.7k		
R156	DS33822	AB Electronic, type C2-45 LIN	2.2k		
R160 +SG		AB Electronic, type K-45 LIN	10k		
R187	DS33814	AB Electronic, type C2-45 LIN	4.7k		
		Transistors			
TR2	BS2920	Texas, TIP3055			
TR8	BS2920	Texas, TIP3055			
TR15	BS2919	Texas, TIP31			
TR18	BS2918	Texas, TIP33 C			
TR22	BS2919	Texas, TIP31			
TR25	BS2920	Texas, TIP3055			
		Cathode Ray Tube and Assembly			
V1	WS28753	GEC (MOV) 1474F/G5			
V1	WS28761	Telefunken, D14-131-GH-18 P31 phosphor			
-	D60719/01	Tube and Screen Assembly (complete) - MOV.			
-	AS1478	Base Socket (MOV) 41/77/842			
-	D60719/62	Tube and Screen Assembly (complete) - Telefunken			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
-	AS1510	Base Socket 30250 (Telefunken)			
		Miscellaneous			
DL1	D60655	Delay Line Assembly			
FS1	RS23087	Fuse Link 1A, Beswick TDC123 (220 V) antisurge			
FS1	RS23093	Fuse Link 2A, Beswick TDC123 (110 V) antisurge			
L1	C60750	H.F. Coil			
L2	C60750	H.F. Coil			
-	C61948	Lead, Mains			
ILP1	JS14102	Neon, Osmor, type 250/1/Red.			
ILP2					
ILP3		Lamp, 14 V 0.75 W Vitality Bulbs Ltd., type LES 682.			
ILP4					
ILP5					
PLA	AS0289	Plug, Bulgin, P429			
PLB	As SKE				
PLC	As SKE				
PLD	AS0588	Plug, Ether, D2-P			
SKA	AS1469	Socket, Greenpar, type GE35026			
SKB	AS1509	Socket McMurdo, type RS16			
SKC	As SKB				
SKD	As SKA				
SKE	AS1400	Socket, Ether, type D2-SP			
SKF	As SKA				
SKG	As SKE				
SKH	AS0441	Socket, Spear Eng., type S192(Black)			
SKJ	As SKH				
SKK	As SKH				
SKL	As SKH				
SKM	AS1513	Socket, Ether, type D2.S			
SA	See R40				
SB	QS22301	Switch, slider, Switchcraft, type 46256 LF.2p - 2pos.			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
SC	QS22302	Switch, 3pos, 4pole, Switchcraft, type 4933IL			
SD	QS22309	Switch, Push-button, Fujisoku MSP205 R			
SE	D60564	Switch (cal)			
SF	D60565	Switch (X Mode)			
SG	See R160				
T1	D60612	Transformer			

CARD 1

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Capacitors (fixed) µF			
C1		Mullard 016/18229	22	+500 -10	63 V
C2		Mullard 016/18229	22	+500 -10	63 V
C4	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
C5		Mullard 015/15159	15	+50 -10	16 V
C7	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C8		Mullard 015/15159	15	+50 -10	16 V
C46	CS30958	Erie 831/K350081	1000p	20	500 V
C63	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
C64	CS30124	STC, PMA 0.1k 100	0.1	10	100 V
C89		Mullard 015-18228	2.2	+50 -10	63 V
		Diodes			
D1	BS2528	Mullard BYX36/150			
D2	BS2528	Mullard BYX36/150			
D3	BS2528	Mullard BYX36/150			
D4	BS2528	Mullard BYX36/150			
D5	BS2528	Mullard BYX36/150			
D6	BS2528	Mullard BYX36/150			
D7	BS2542	STC, 1N4148			
D8	BS2542	STC, 1N4148			
D9	BS2942	Mullard BZY88/C5V1			
D10	BS2525	Mullard BZY88/C6V2			
D11	BS2542	STC, 1N4148			
D22	BS2526	Mullard BZY88/C9V1			
D31	BS2542	STC, 1N4148			
D32	BS2542	STC, 1N4148			
		Resistors (fixed) Ω			
R1	DS32512	Electrosil TR5 or MR30	150k	2	½ W
R2	DS32358	Electrosil TR5	680	2	½ W
R3	DS32358	Electrosil TR5	680	2	½ W
R4	DS32366	Electrosil TR5	100k	2	½ W

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R5	DS7302	Electrosil TR5	10	2	½ W
R6	DS33817	Radio Resistor, SKA1	0.56	10	1 W
R7	DS32131	Electrosil TR5	2.2 k	2	½ W
R8	DS33754	Mullard MR25	1 k	2	
R9	DS32357	Electrosil TR5	1.5 k	2	½ W
R10	DS32358	Electrosil TR5	680	2	½ W
R11	DS32132	Electrosil TR5	2.7 k	2	½ W
R12	DS33768	Mullard MR25	3.9 k	2	
R14	DS33768	Mullard MR25	3.9 k	2	
R15	DS33817	Radio Resistor, SKA1	0.56	10	1 W
R16	DS33883	Painton, type MV1	390	5	2.5W
R17	DS7302	Electrosil TR5	10	2	½ W
R18	DS33826	Mullard MR25	2.15k	1	
R19	DS33826	Mullard MR25	2.15k	1	
R20	DS32131	Electrosil TR5	2.2 k	2	½ W
R21	DS32368	Electrosil TR5	6.8 k	2	½ W
R22	DS33754	Mullard MR25	1 k	2	
R23	DS33754	Mullard MR25	1 k	2	
R24	DS32409	Electrosil TR5	3.9 k	2	½ W
R25	DS32132	Electrosil TR5	2.7 k	2	½ W
R26	DS32132	Electrosil TR5	2.7 k	2	½ W
R27	DS32520	Electrosil TR5	68	2	½ W
R79	DS32409	Electrosil TR5	5.6 k	2	½ W
R81	DS7526	Electrosil TR5	10 k	2	½ W
R82	DS32366	Electrosil TR5	100 k	2	½ W
R112	DS33776	Mullard MR25	8.2 k	2	
R114	DS33770	Mullard MR25	4.7 k	2	
R115	DS32372	Electrosil TR5	18 k	2	½ W
R116	DS32366	Electrosil TR5	100 k	2	½ W
R117	DS33754	Mullard MR25	1 k	2	
R118	DS32370	Electrosil TR5	33 k	2	½ W
R120	DS32358	Electrosil TR5	680	2	½ W
R121	DS7526	Electrosil TR5	10 k	2	½ W
R122	DS33695	Welwyn type 4034/Z	4 k	½	

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R184	DS33754	Mullard MR25	1 k	2	
R223	DS33734	Mullard MR25	150	2	
R229	DS33760	Mullard MR25	1.8 k	2	
		Resistors (variable)			
R13	FS10299	Plessey HP/PC Dealer LIN (or Erie 80P/2)	1 k	20	$\frac{1}{4}$ W
R113	FS10308	Plessey MP/PC Dealer LIN (or Erie 80P/2)	2.2k	20	$\frac{1}{4}$ W
R119	FS10297	Plessey MP/PC Dealer LIN (or Erie 80P/2)	470	20	$\frac{1}{4}$ W
		Transistors			
TR1	BS2533	Mullard BFY51			
TR3	BS2832	Mullard BC148			
TR4	BS2832	Mullard BC148			
TR5	BS2832	Mullard BC148			
TR6	BS2832	Mullard BC148			
TR7	BS2832	Mullard BC148			
TR9	BS2159	Mullard BCY72			
TR11	BS2519	Mullard BCY72			
TR12	BS2519	Mullard BCY72			
TR13	BS2519	Mullard BCY72			
TR14	BS2519	Mullard BCY72			
TR39	BS2602	Ferranti ZTX351L or Mullard BSX21			
TR40	BS2602	Ferranti ZTX351L or Mullard BSX21			
TR41	BS2921	Motorola 2N5400			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
C10	CS30960	Erie 21102-100-0470-AH0101	47	+100 -20	100V
C12		Mullard 016-18109	10	+50 -10	63 V
C13	CS30960	Erie 21102-100-0470-AH0101	47	+100 -20	100V
C14	CS30960	Erie 21102-100-0470-AH0101	47	+100 -20	100V
C15	CS30960	Erie 21102-100-0470-AH0101	47	+100 -20	100V
C19	CS30954	Erie 801/K800011	0.01	+80 -20	250V
C65	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C66	CS30943	Erie 831/K350081	1500 p	+40 -20	500V
C67	CS30960	Erie 21102-100-0470-AH0101	47	+100 -20	100V
		Diodes			
D12	BS2542	STC 1N4148			
D13	BS2528	Mullard BYX36/150			
D14	BS2528	Mullard BYX36/150			
D15	BS2528	Mullard BYX36/150			
D16	BS2528	Mullard BYX36/150			
D17	BS2528	Mullard BYX36/150			
D18	BS2528	Mullard BYX36/150			
D41	BS2528	Mullard BYX36/150			
D42	BS2528	Mullard BYX36/150			
		Resistors (fixed) Ω			
R28	DS32362	Electrosil TR5	3.3k	2	½ W
R29	DS33823	Mullard MR25	2.87k	1	
R30	DS33826	Mullard MR25	2.15k	1	
R31	DS32371	Electrosil TR5	68 k	2	½ W
R32	DS7526	Electrosil TR5	10 k	2	½ W
R33	DS33818	Radio Resistor, type SKA1	1	10	1 W
R34	DS32512	Electrosil TR5	150 k	2	½ W
R35	DS32127	Electrosil TR5	470	2	½ W
R36	DS33824	Mullard MR25	18.7k	1	

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R37	DS33825	Mullard MR25	4.64k	1	
R38	DS32361	Electrosil TR5	100	2	$\frac{1}{2}$ W
R111	DS7479	Electrosil TR5	1 k	2	$\frac{1}{2}$ W
R133	DS33819	Radio Resistor, type SKA1	1.5	10	1 W
R182	DS7302	Electrosil TR5	10	2	$\frac{1}{2}$ W
R183	DS7302	Electrosil TR5	10	2	$\frac{1}{2}$ W
R215	DS33800	Mullard MR25	82 k	2	
R216	DS33746	Mullard MR25	470	2	
R217	DS33812	Mullard MR25	270k	2	
		Transistors			
TR10	BS2832	Mullard BC148			
TR16	BS2832	Mullard BC148			
TR17	BS2561	Mullard BF178			
TR19		Ferranti ZTX351L or Mullard BSX21			
TR20		Ferranti ZTX351L or Mullard BSX21			
TR21	BS2519	Mullard BCY72			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Capacitors (fixed) µF			
C16	CS30947	Mullard C280AE/P47K/040	0.047	10	250V
C17	CS30968	Erie, CD7/K120051	1000p	+80 -20	4kV
C18	CS30947	Mullard C280AE/P47K/040	0.047	10	250V
C19	CS30452	Erie CP5/K800011	0.03	+80 -20	1.5kV
C23	CS30452	Erie CP5/K800011	0.03	+80 -20	1.5kV
C24	CS30452	Erie CP5/K800011	0.03	+80 -20	1.5kV
C25	CS30452	Erie CP5/K800011	0.03	+80 -20	1.5kV
C26	CS30958	Erie 831/K350081	1000p	+40 -20	500V
C27	CS30452	Erie CP5/K800011	0.03	+80 -20	1.5kV
C28	CS30452	Erie CP5/K800011	0.03	+80 -20	1.5kV
C87	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
		Diodes			
D19	BS2542	STC 1N4148			
D24	BS2915	Bourne, SCM30			
D25	BS2915	Bourne, SCM30			
		Resistors			
R42	DS33914	Welwyn 4037/G	9.76M	1	
R43	DS32359	Electrosil TR5	4.7k	2	½ W
R44	DS32366	Electrosil TR5	100k	2	½ W
R45	DS32359	Electrosil TR5	4.7k	2	½ W
R46	DS7479	Electrosil TR5	1 k	2	½ W
R47	DS32440	Electrosil TR5	15 k	2	½ W
R48	DS32371	Electrosil TR5	68 k	2	½ W
R50	DS32512	Electrosil TR5	150k	2	½ W
R51		Welwyn, type 3963	22 M	10	½ W
R60	DS33685	Morganite, type S	3.9M	10	½ W
R73	DS32512	Electrosil TR5	150k	2	½ W
R85	DS33127	Electrosil TR5	180k	2	½ W
R209	DS32365	Electrosil TR5	270	2	½ W

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Resistors (variable) ⏛			
R41	FS10300	Plessey, MP/PC Dealer LIN (or Erie 80P/2)	47k	20	¼ W
R49	FS10412	Plessey, MP/PC Dealer LIN (or Erie 80P/2)	2.2M	20	¼ W
		Transistors			
TR23	BS2832	Mullard BC148			
TR24	BS2519	Mullard BCY72			
		Miscellaneous			
L5	ES8407	Choke, RF, Painton type C12	100μH	10	
FS2	RS23036	Fuse Link 1A, Bulgin F270			
T2	D60610	Transformer, e.h.t. SEL			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Capacitors (fixed) µF			
C20	CS30304	Erie 831/NPO	10p	20	500V
C21	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C29	CS30960	Erie 21102-100-0470-AH0101	47	+100 -20	100V
C30	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C32	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C33	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C34	CS30958	Erie 831/K350081	1000p	20	500V
C35	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C54	CS30954	Erie 801/K800011	0.01	+80 -20	250V
C69	CS30958	Erie 831/K3500081	1000p	20	500V
C73	CS30954	Erie 801/K800011	0.01	+80 -20	250V
C90	CS30467	Erie XD/P100	1p	+0.25p	750V
		Diodes			
D27	BS2542	STC 1N4148			
D28	BS2542	STC 1N4148			
D29	BS2545	I.T.T., ITT2002			
D30	BS2545	I.T.T., ITT2002			
D45	BS2542	STC 1N4148			
D46	BS2542	STC 1N4148			
		Resistors (fixed) Ω			
R53	DS7526	Electrosil TR5	10 k	2	½ W
R55	DS33686	Morganite, type S	680k	10	½ W
R56	DS32132	Morganite, type S	10M	10	½ W
R57	DS32132	Morganite, type S	10M	10	½ W
R58	DS33884	Morganite, type S	5.6M	10	½ W
R64	DS32375	Electrosil TR5	1.8k	2	½ W
R65	DS7479	Electrosil TR5	1 k	2	½ W
R66	DS7491	Electrosil TR5	1.2 k	2	½ W

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R67	DS7480	Electrosil TR5	5.6k	2	½ W
R68	DS7480	Electrosil TR5	5.6k	2	½ W
R69	DS32131	Electrosil TR5	2.2k	2	½ W
R70	DS7480	Electrosil TR5	5.6 k	2	½ W
R71	DS32440	Electrosil TR5	15k	2	½ W
R72	DS32363	Electrosil TR5	22k	2	½ W
R74	DS7479	Electrosil TR5	1 k	2	½ W
R75	DS32373	Electrosil TR5	39k	2	½ W
R76	DS7526	Electrosil TR5	10k	2	½ W
R77	DS32362	Electrosil TR5	3.3k	2	½ W
R78	DS32385	Electrosil TR5	150	2	½ W
R80	DS32131	Electrosil TR5	2.2k	2	½ W
R83	DS32131	Electrosil TR5	2.2k	2	½ W
R84	DS7526	Electrosil TR5	10k	2	½ W
R210	DS33884	Morganite, type S	5.6M	10	½ W
		Resistors (variable)			
R54	FS10251	Plessey MP/PC Dealer LIN (or Erie 80P/2)	1 M	20	¼ W
		Transistors			
TR26	BS2756	Texas, TIS48			
TR27	BS2756	Texas, TIS48			
TR29	BS2916	S.G.S., V765			
TR30	BS2561	Mullard BF178			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Capacitors (fixed) µF			
C22	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C31	CS30954	Erie 801/K800011	0.01	+80 -20	250V
C47	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C48	CS30943	Erie 831/K350081	1500p	+40 -20	500V
C49	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C50		Mullard 016-17479	47	+50 -10	40 V
C51		Mullard 017-16221	220	+50 -10	25V
C52		Mullard 015-15159	15	+50 -10	16V
C53		Mullard 015-15159	15	+50 -10	16V
C55	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C57	CS30954	Erie 801/K800011	0.01	+80 -20	250V
C58	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C60	CS30954	Erie 801/K800011	0.01	+80 -20	250V
C61	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C62	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C74	CS30956	Erie 831/NPO	15p	20	500V
C82	CS30951	Mullard C280AE/P100K/040	0.1	20	250V
C85	CS30467	Erie P100/XD	1p	±0.25p	750V
C86	CS30467	Erie P100/XD	1p	±0.25p	750V
C88		Erie 831/N3300	150p	20	500V
		Capacitors (variable)			
C59	CS30966	Mullard C004EA/3E	07p-3p		
C84	CS30966	Mullard C004EA/3E	07p-3p		
		Diodes			
D20	BS2542	STC, 1N4148			
D21	BS2525	Zener	6.2 V	5	400mW
D33	BS2542	STC, 1N4148			
D34	BS2542	STC, 1N4148			
D35	BS2542	STC, 1N4148			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
D36	BS2542	STC, 1N4148			
D37	BS2542	STC, 1N4148			
D38	BS2542	STC, 1N4148			
D39	BS2542	STC, 1N4148			
D40	BS2542	STC, 1N4148			
		Resistors (fixed) ⏚			
R135	DS32527	Electrosil TR5	1M	2	
R136	DS7449	Electrosil TR5	470k	2	
R137	DS7526	Electrosil TR5	10 k	2	½ W
R138	DS32132	Electrosil TR5	2.7k	2	½ W
R139	DS7479	Electrosil TR5	1 k	2	
R140	DS7480	Electrosil TR5	5.6k	2	½ W
R141	DS32361	Electrosil TR5	100	2	
R142	DS32374	Electrosil TR5	8.2k	2	½ W
R143	DS32362	Electrosil TR5	3.9k	2	½ W
R144	DS32368	Electrosil TR5	6.8k	2	½ W
R145	DS32359	Electrosil TR5	4.7k	2	½ W
R147	DS32127	Electrosil TR5	470	2	½ W
R149	DS32368	Electrosil TR5	6.8k	2	½ W
R150	DS32374	Electrosil TR5	8.2k	2	½ W
R151	DS32362	Electrosil TR5	3.9k	2	½ W
R152	DS32360	Electrosil TR5	47k	2	½ W
R153	DS32362	Electrosil TR5	3.9k	2	½ W
R154	DS32132	Electrosil TR5	2.7k	2	½ W
R155	DS32127	Electrosil TR5	470	2	½ W
R157	DS32375	Electrosil TR5	1.8k	2	½ W
R158	DS32234	Electrosil TR5	47	2	½ W
R159	DS32383	Electrosil TR5	560	2	½ W
R161	DS32132	Electrosil TR5	2.7k	2	½ W
R162	DS32368	Electrosil TR5	6.8k	2	½ W
R163	DS32132	Electrosil TR5	2.7k	2	½ W
R164	DS32440	Electrosil TR5	15k	2	½ W

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R165	DS32360	Electrosil TR5	47k	2	½ W
R166	DS32359	Electrosil TR5	4.7k	2	½ W
R167	DS32373	Electrosil TR5	39 k	2	½ W
R168	DS7479	Electrosil TR5	1 k	2	
R169	DS32131	Electrosil TR5	2.2k	2	½ W
R170	DS32440	Electrosil TR5	15 k	2	½ W
R171	DS32360	Electrosil TR5	47 k	2	½ W
R172	DS32359	Electrosil TR5	4.7k	2	½ W
R173	DS32373	Electrosil TR5	39k	2	½ W
R174	DS7479	Electrosil TR5	1 k	2	
R175	DS32131	Electrosil TR5	2.2 k	2	½ W
R176	DS7302	Electrosil TR5	10	2	½ W
R178	DS32361	Electrosil TR5	100	2	
R185	DS32357	Electrosil TR5	1.5k	2	½ W
R192	DS32375	Electrosil TR5	1.8k	2	½ W
R193	DS32362	Electrosil TR5	3.9k	2	½ W
R194	DS32127	Electrosil TR5	470	2	½ W
R214		Electrosil TR5	470	2	
R224	DS33730	Mullard MR25	100	2	
		Resistors(variable)			
R146	FS10297	Plessey, MP/PC Dealer LIN	470	20	¼ W
R148	FS10405	Plessey, MP/PC Dealer LIN (or Erie 80P/2)	10k	20	¼ W
R186	FS10308	Plessey, MP/PC Dealer LIN	2.2k	20	¼ W
		Transistors			
TR28	BS2756	Texas TIS48			
TR42	BS2758	Texas 2N5246			
TR43	BS2519	Mullard BCY72			
TR44	BS2756	Texas TIS48			
TR45	BS2756	Texas TIS48			
TR46	BS2519	Mullard BCY72			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
TR47	BS2554	Texas TIS50			
TR48	BS2916	S.G.S. V765			
TR49	BS2561	Mullard BF178			
TR50	BS2554	Texas TIS50			
TR51	BS2916	S.G.S. V765			
TR52	BS2561	Mullard BF178			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Capacitors(fixed) µF			
C39	CS30957	Erie 861/NPO	2.2p	±0.5p	500 V
C40	CS30957	Erie 831/N1500	33p	20	500 V
C41	CS30959	Erie 831/N5600	330p	20	500 V
C42	CS30955	Erie 801/K7004	4700p	+40 -20	500 V
C43	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C44	CS30958	Erie 831/K350081	1000p	+40 -20	500 V
C45	CS30958	Erie 831/K350081	1000p	+40 -20	500 V
C78	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
C80	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
		Capacitors (variable)			
C37	CS30196	Steatite 10S-TRIKO-06/N470	4p-20p		250 V
C38	CS30190	Steatite 10S-TRIKO-06/N750	10p-40p		250 V
C72	CS30969	Steatite 5S-TRIKO-03/N033	2.5p-5p		63 V
		Diodes			
D43	BS2785	Zener	13V		
D44	BS2623	Zener	5.6 V		
D47	BS2785	Zener	13V		
D48	BS2623	Zener	5.6 V		
D49	BS2542	STC, 1N4148			
D50	BS2542	STC, 1N4148			
		Resistors (fixed) Ω			
R86	DS32131	Electrosil TR5	2.2k	2	½ W
R87	DS33697	Electrosil TR5	75	2	½ W
R88	DS33697	Electrosil TR5	75	2	½ W
R89	DS32568	Electrosil TR5	56k	2	½ W
R90	DS32234	Electrosil TR5	47	2	½ W
R91	DS32234	Electrosil TR5	47	2	½ W

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R92	DS33752	Mullard MR25	820	2	
R93	DS32383	Electrosil TR5	560	2	½ W
R94	DS33752	Mullard MR25	820	2	
R95	DS33696	Electrosil TR6	1.8k	5	1 W
R96	DS33696	Electrosil TR6	1.8k	5	1 W
R97	DS32356	Electrosil TR5	180	2	
R98	DS32356	Electrosil TR5	180	2	
R100	DS7491	Electrosil TR5	1.2k	2	½ W
R101	DS7491	Electrosil TR5	1.2k	2	½ W
R102	DS32127	Electrosil TR5	470	2	½ W
R103	DS5554	Electrosil TR6	1 k	5	1 W
R104	DS5554	Electrosil TR6	1 k	5	1 W
R105	DS32127	Electrosil TR5	470	2	½ W
R106	DS32362	Electrosil TR5	3.3k	2	½ W
R107	BS2969	Mullard VA1038 (thermistor)	1.3 k		
R108	DS32374	Electrosil TR5	8.2 k	2	½ W
R109	DS32376	Electrosil TR5	27 k	2	½ W
R110	DS32568	Electrosil TR5	56 k	2	½ W
R179	DS32373	Electrosil TR5	39 k	2	½ W
R180	DS6438	Electrosil TR6	1.5k	5	1W
R181	DS32127	Electrosil TR5	470	2	½ W
R188	DS32127	Electrosil TR5	470	2	½ W
R189	DS6438	Electrosil TR6	1.5k	5	1 W
R190		Welwyn F76P	270	5	
R191		Welwyn F76P	270	5	
R195	DS7491	Electrosil TR5	1.2k	2	½ W
R196	DS7491	Electrosil TR5	1.2k	2	½ W
R197	DS32128	Electrosil TR5	330	2	½ W
R198	DS32361	Electrosil TR5	100	2	½ W
R200	DS32357	Electrosil TR5	1.5k	2	½ W
R201	DS33819	Radio Resistor, SKA1	1.5	10	1 W

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Resistors (variable)			
R99	FS10297	Plessey MP/PC Dealer LIN	470	20	$\frac{1}{4}$ W
		Transistors			
TR31	BS2835	Texas 2N5179			
TR32	BS2519	Mullard BCY72			
TR33	BS2835	Texas 2N5179			
TR34	BS2835	Texas 2N5179			
TR35	BS2835	Texas 2N5179			
TR36	BS2756	Texas TIS48			
TR37	BS2756	Texas TIS48			
TR38	BS2836	Texas 2N5109			
TR53	BS2836	Texas 2N5109			

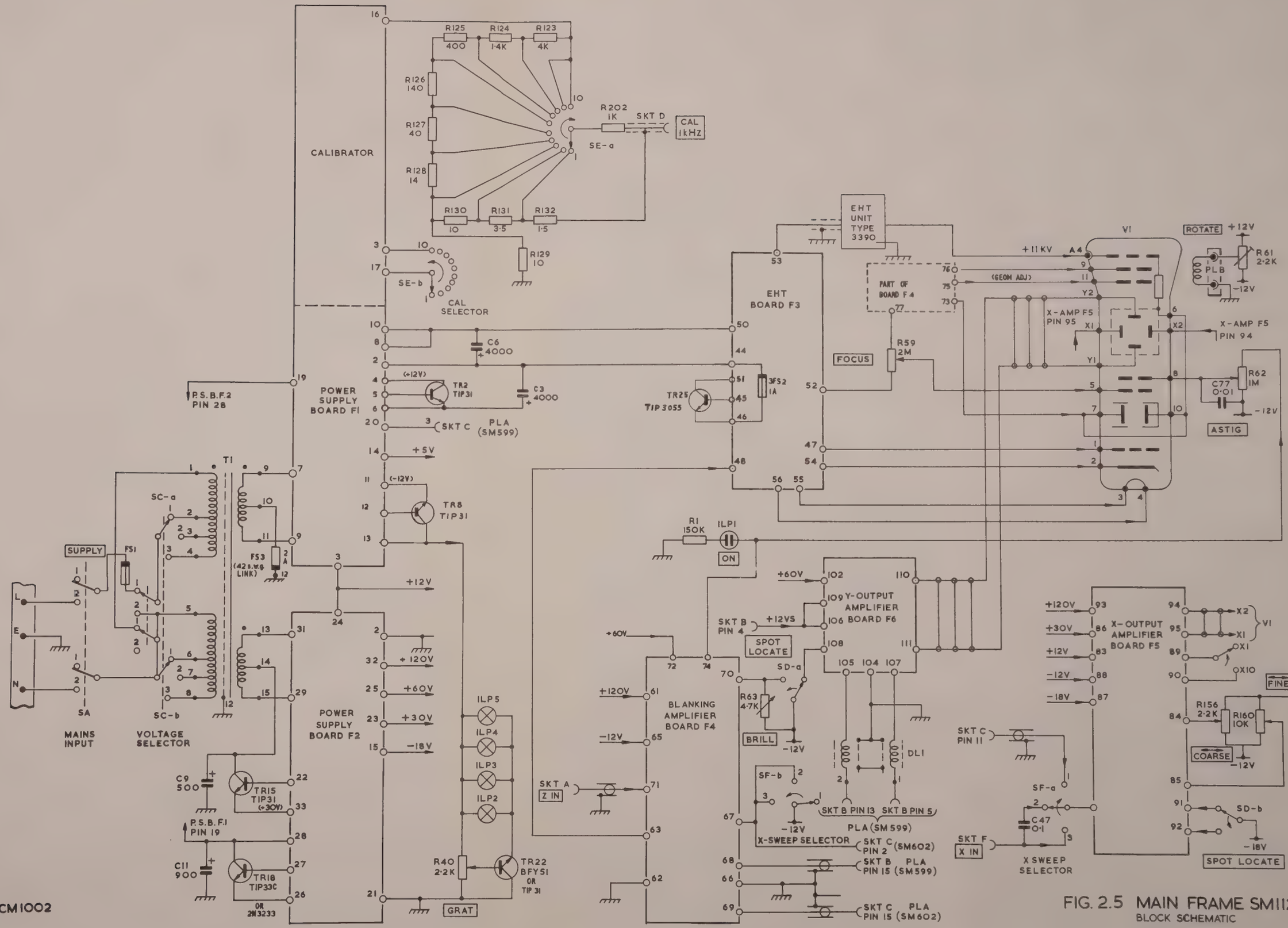

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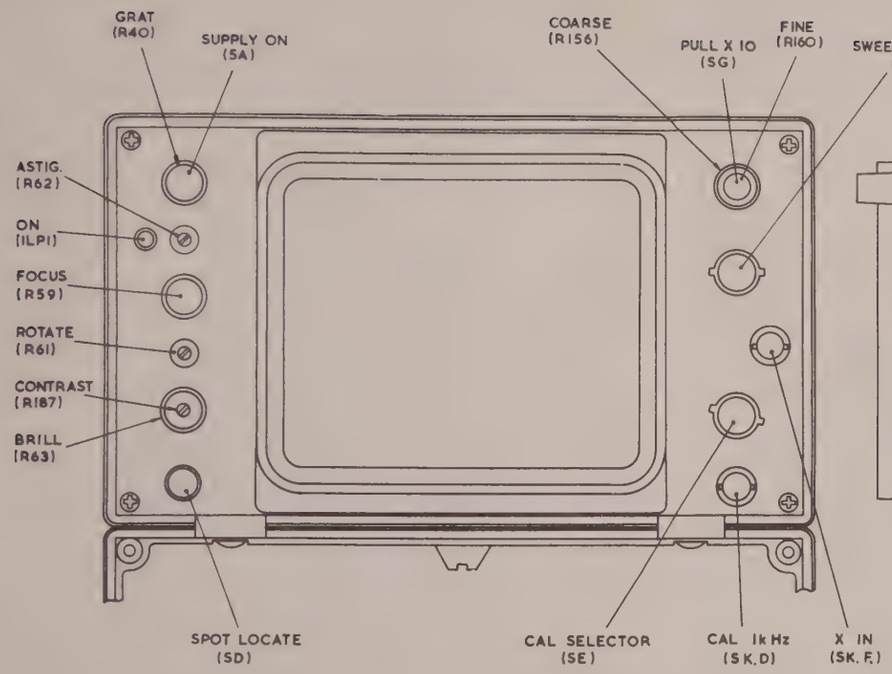
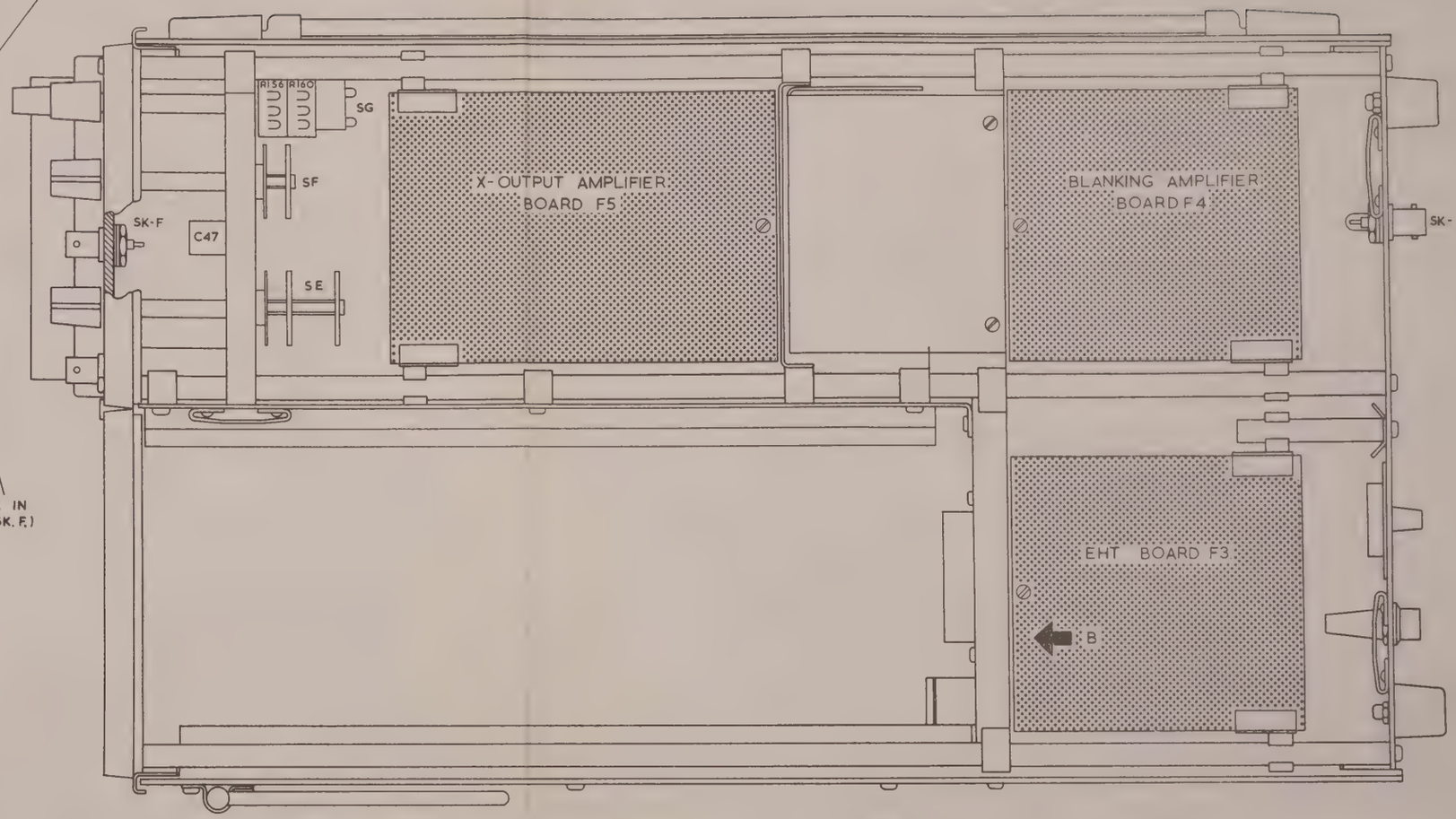
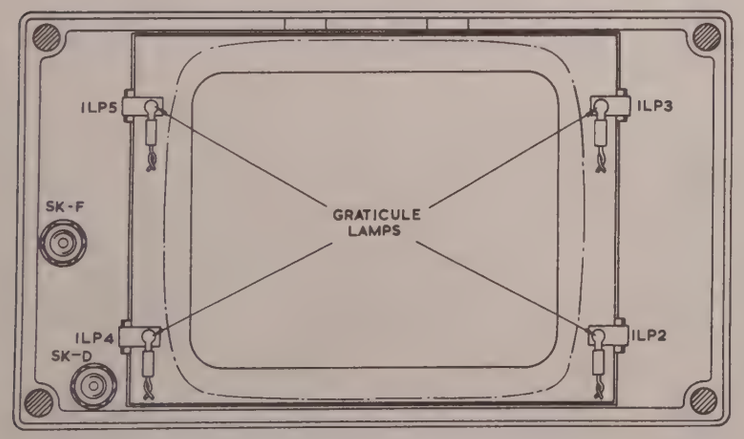
FIG. 2.5 MAIN FRAME SM112
BLOCK SCHEMATIC

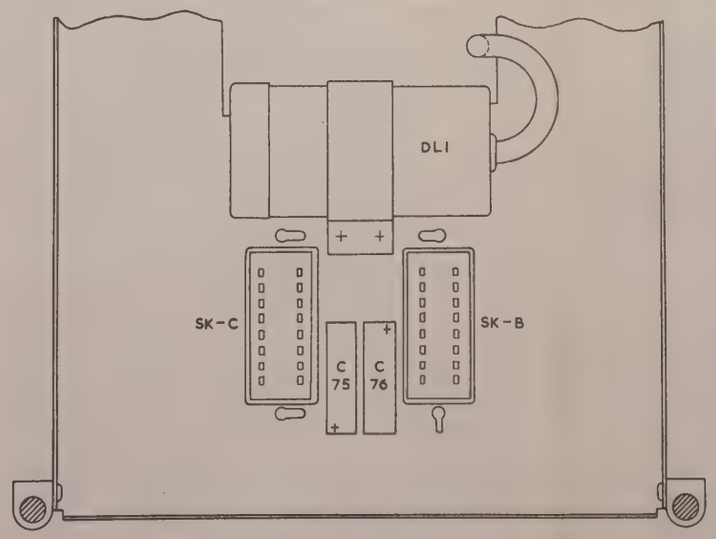


FRONT PANEL

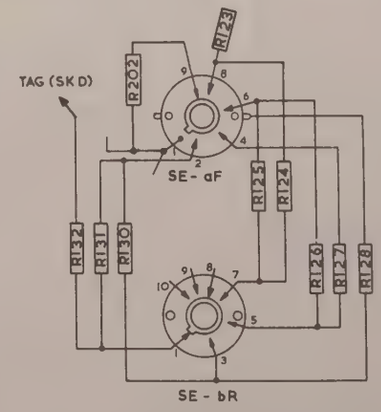




VIEW INSIDE FRONT PANEL

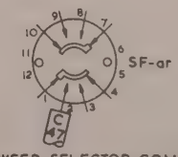


VIEW ON ARROW B



IDENTIFICATION OF COMPONENTS ON SWITCH SE (CAL SELECTOR)

NOTE
DRG. No. E. 60520/5



SWEEP SELECTOR COMPONENTS

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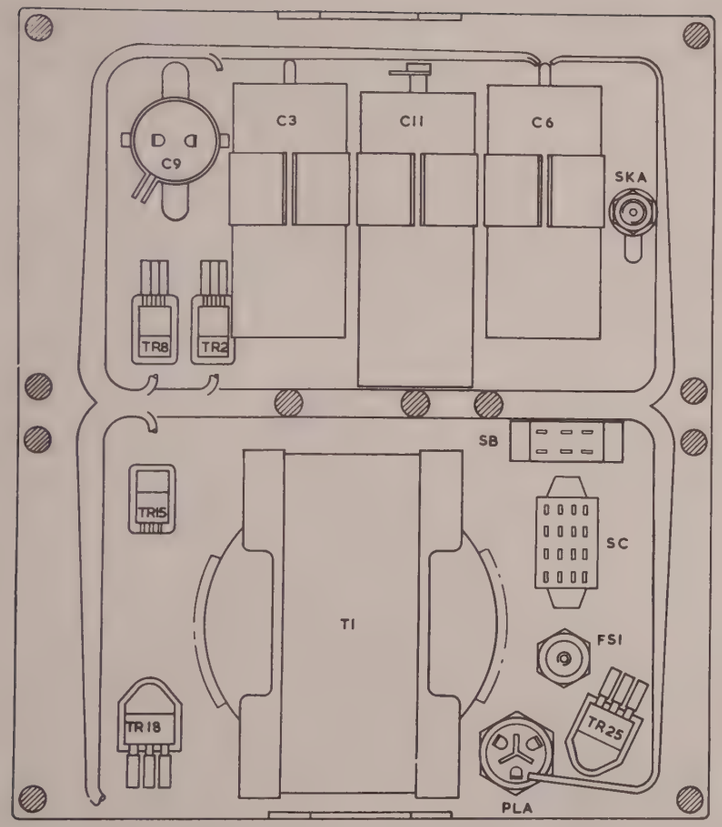
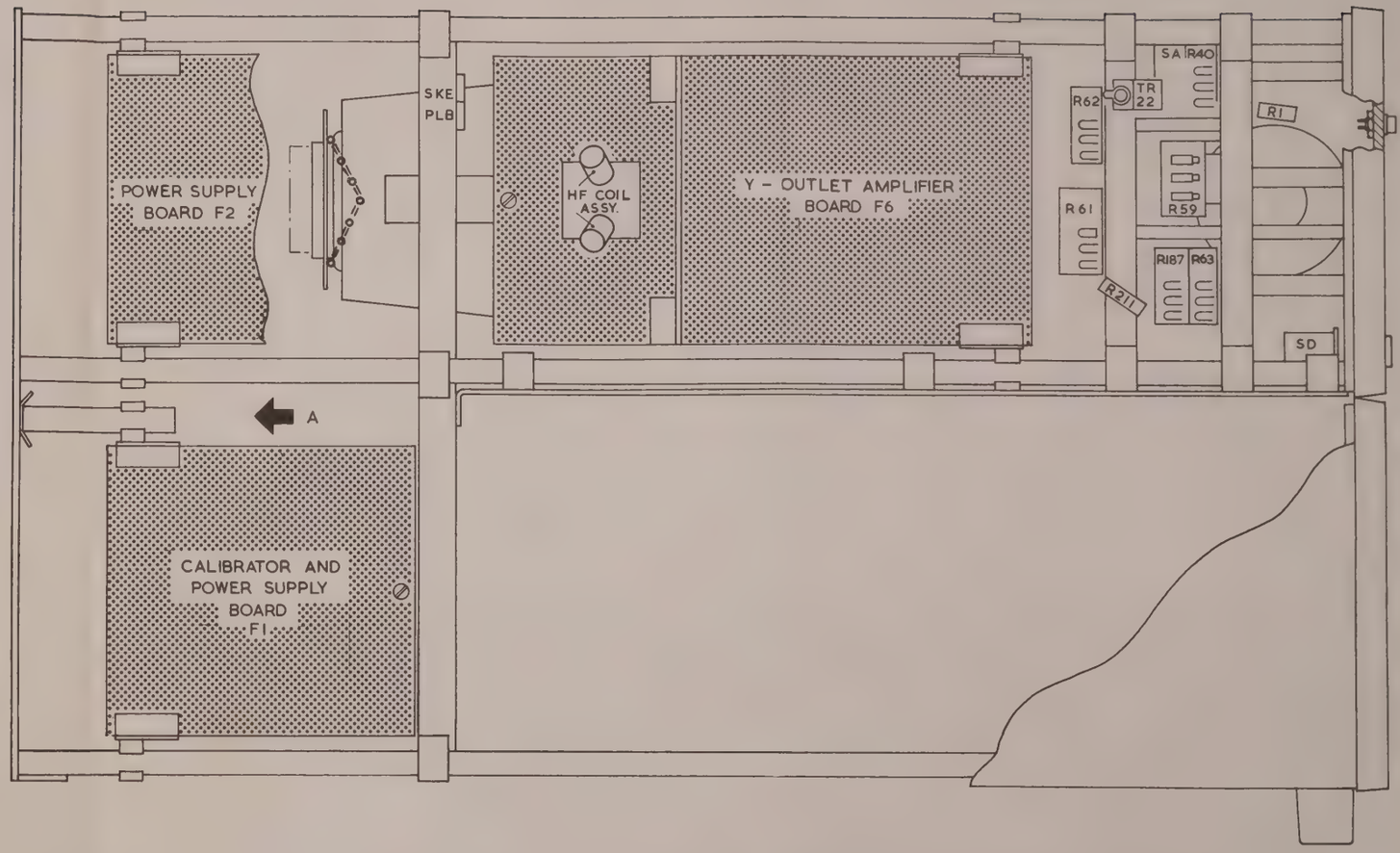
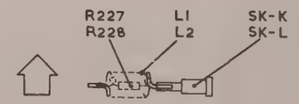
FIG. 2. 6. MAIN FRAME SM112
COMPONENT LAYOUT (SHT. 1)



VIEW ON ARROW A





HF COIL ASSEMBLY

NOTES

DWG. No. 60520/6 SHT. 2 OF 2

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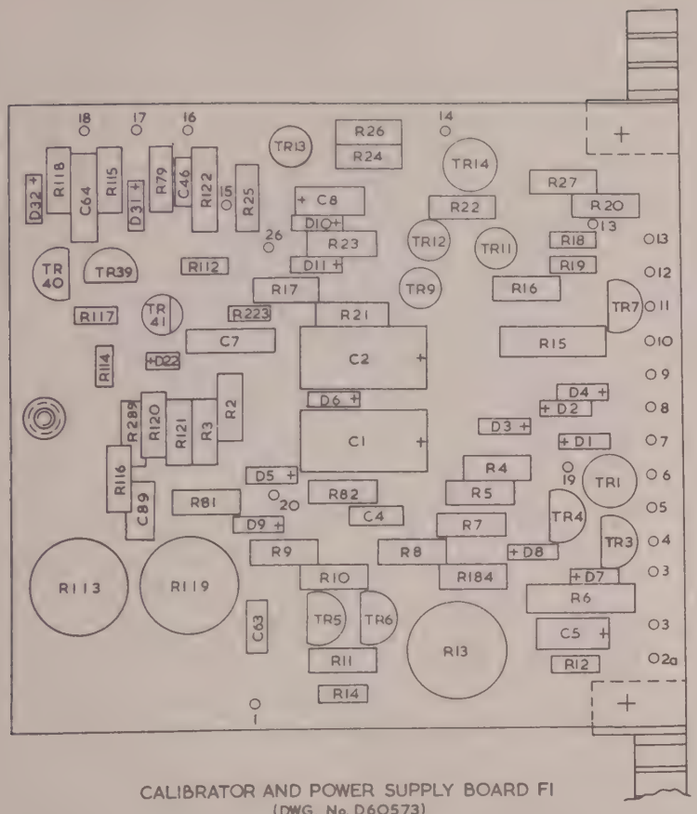
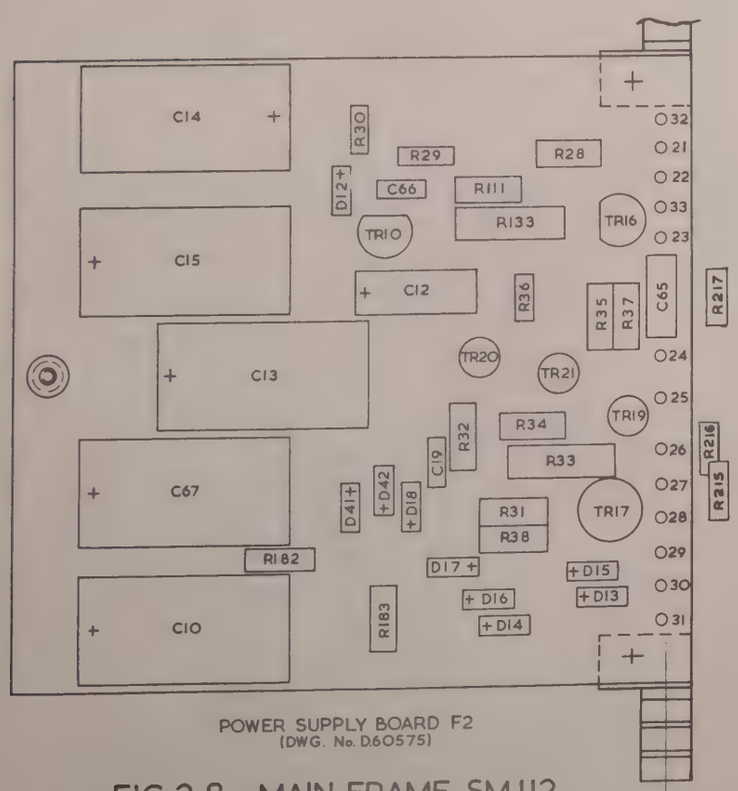
FIG. 2.7 MAIN FRAME SM112
COMPONENT LAYOUT (SH. 2)

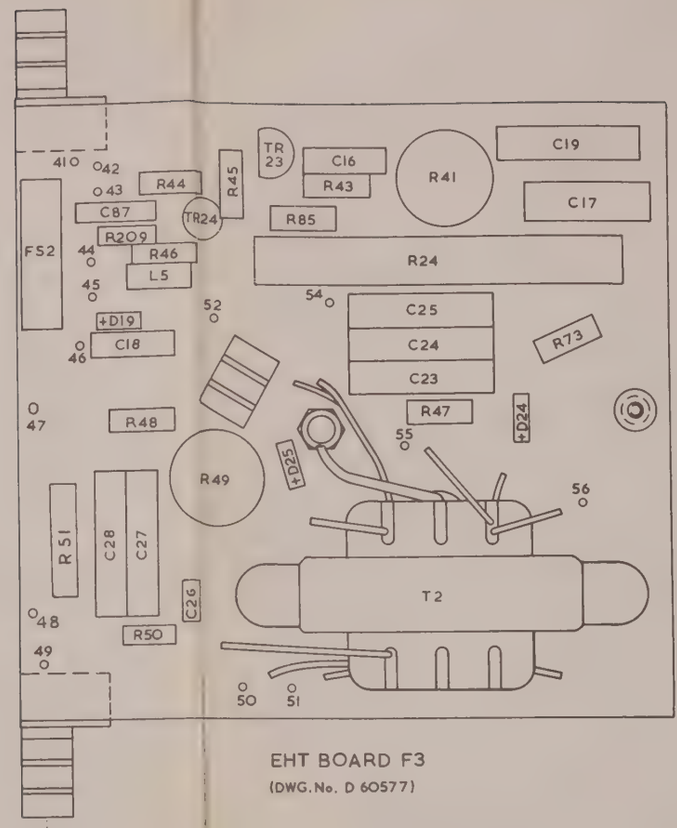


CALIBRATOR AND POWER SUPPLY BOARD F1
(DWG. No. D60573)

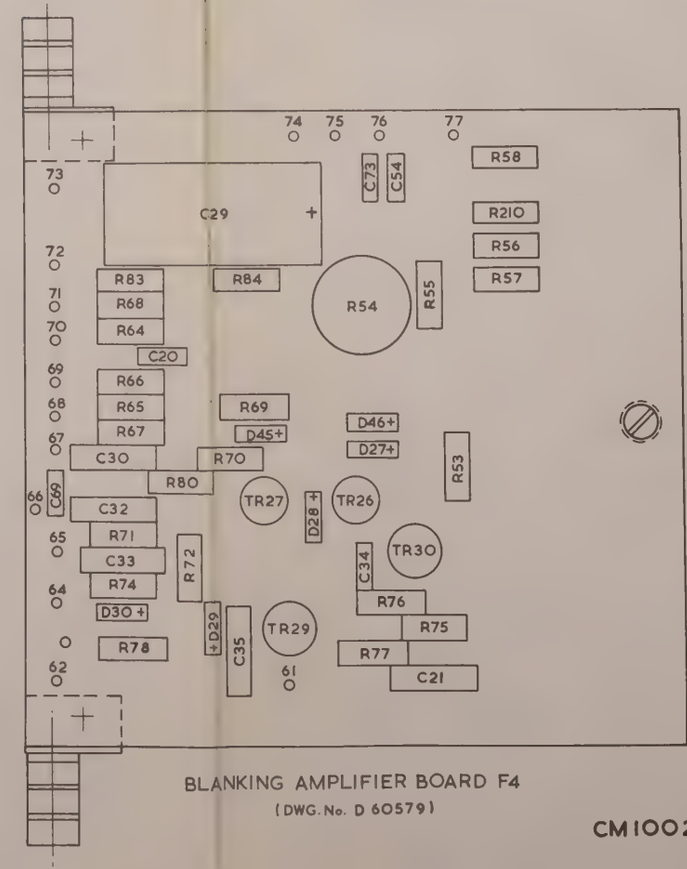


POWER SUPPLY BOARD F2
(DWG. No. D60575)

FIG. 2.8 MAIN FRAME SM112
BOARD LAYOUTS SHT. 1

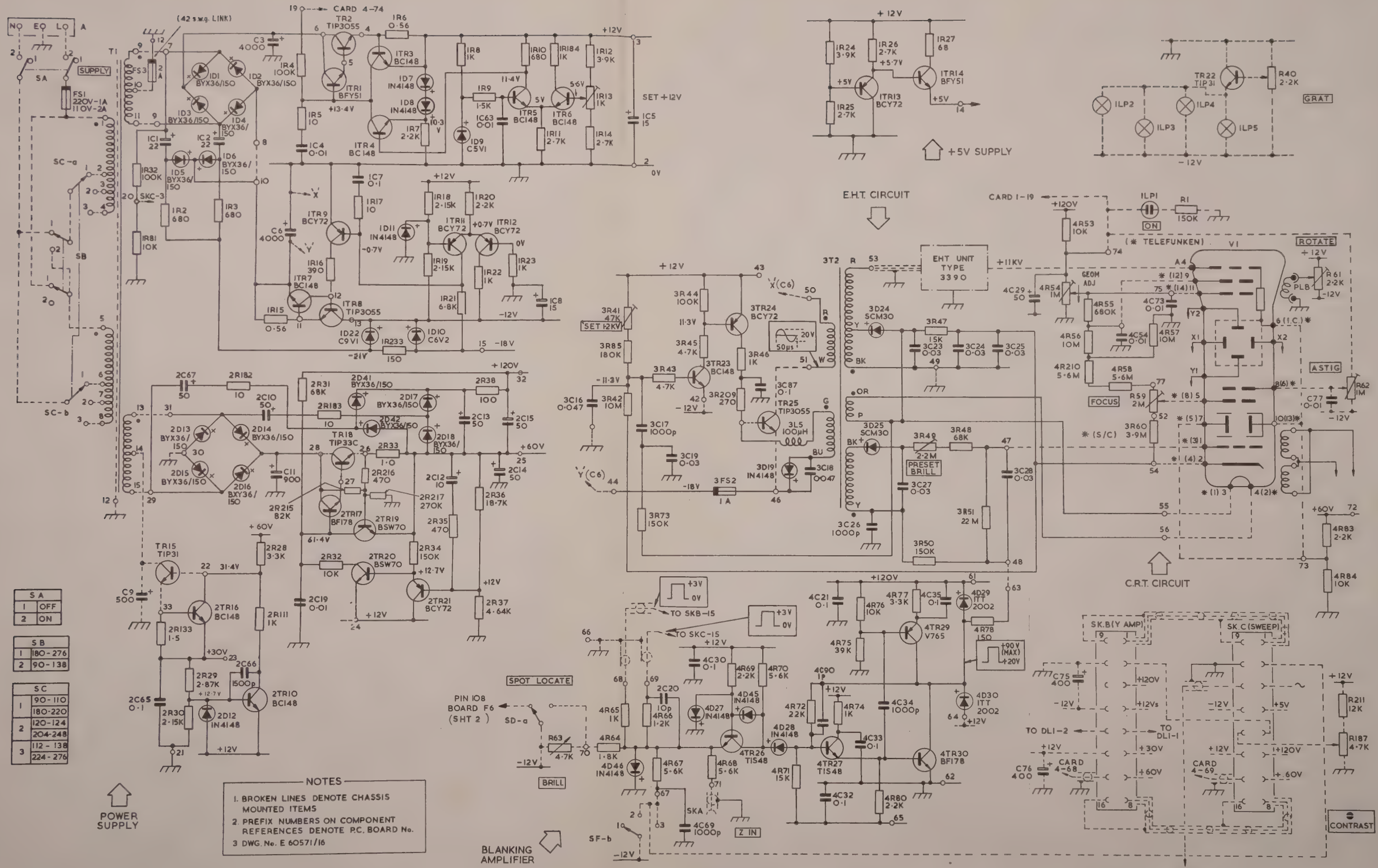


EHT BOARD F3
(DWG. No. D 60577)



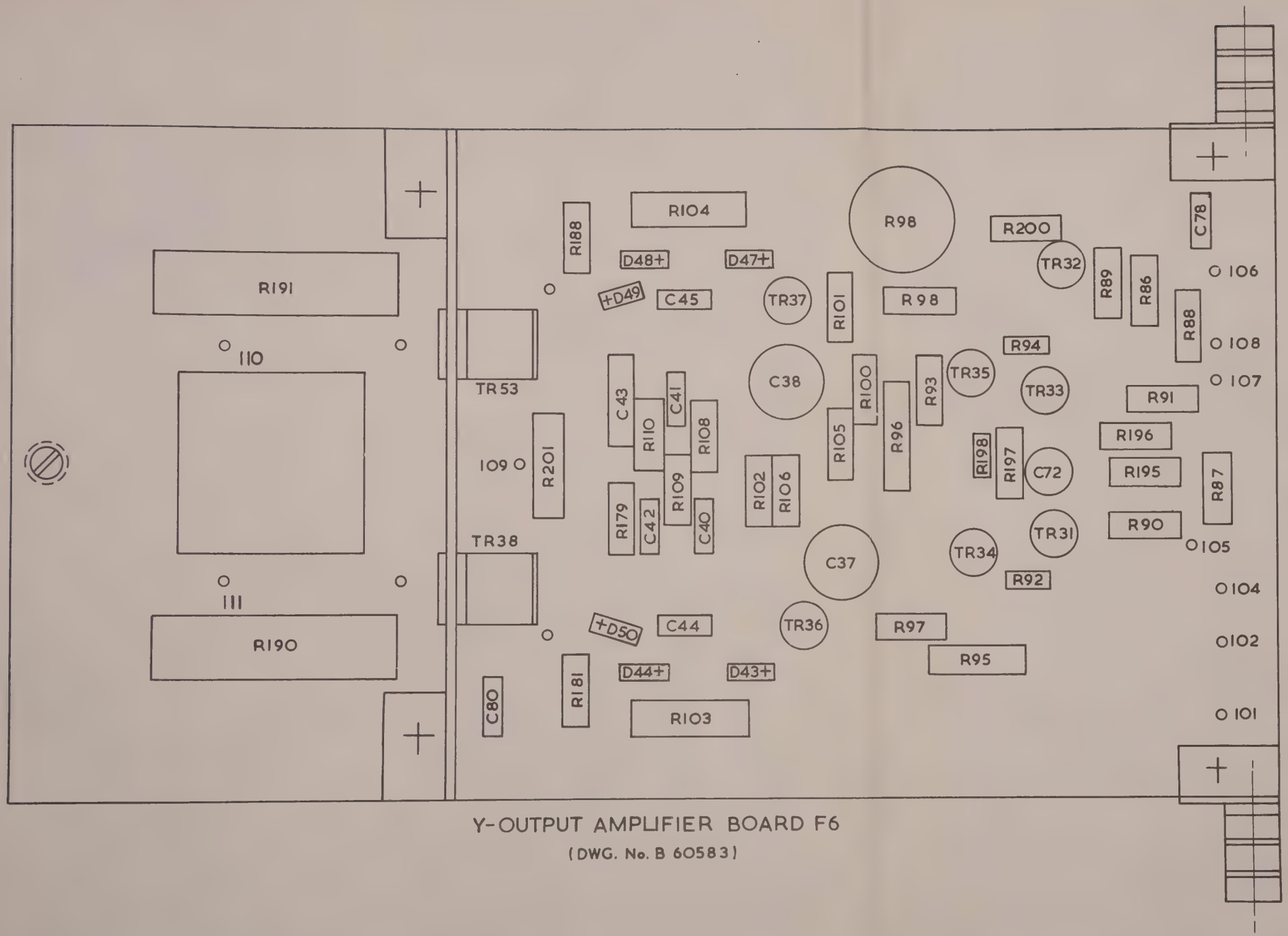
BLANKING AMPLIFIER BOARD F4
(DWG. No. D 60579)

CM1002



CM1002

FIG .2.9 MAIN FRAME SM112
CIRCUIT DIAGRAM (SHT.1)
POWER SUPPLIES AND CRT CIRCUIT



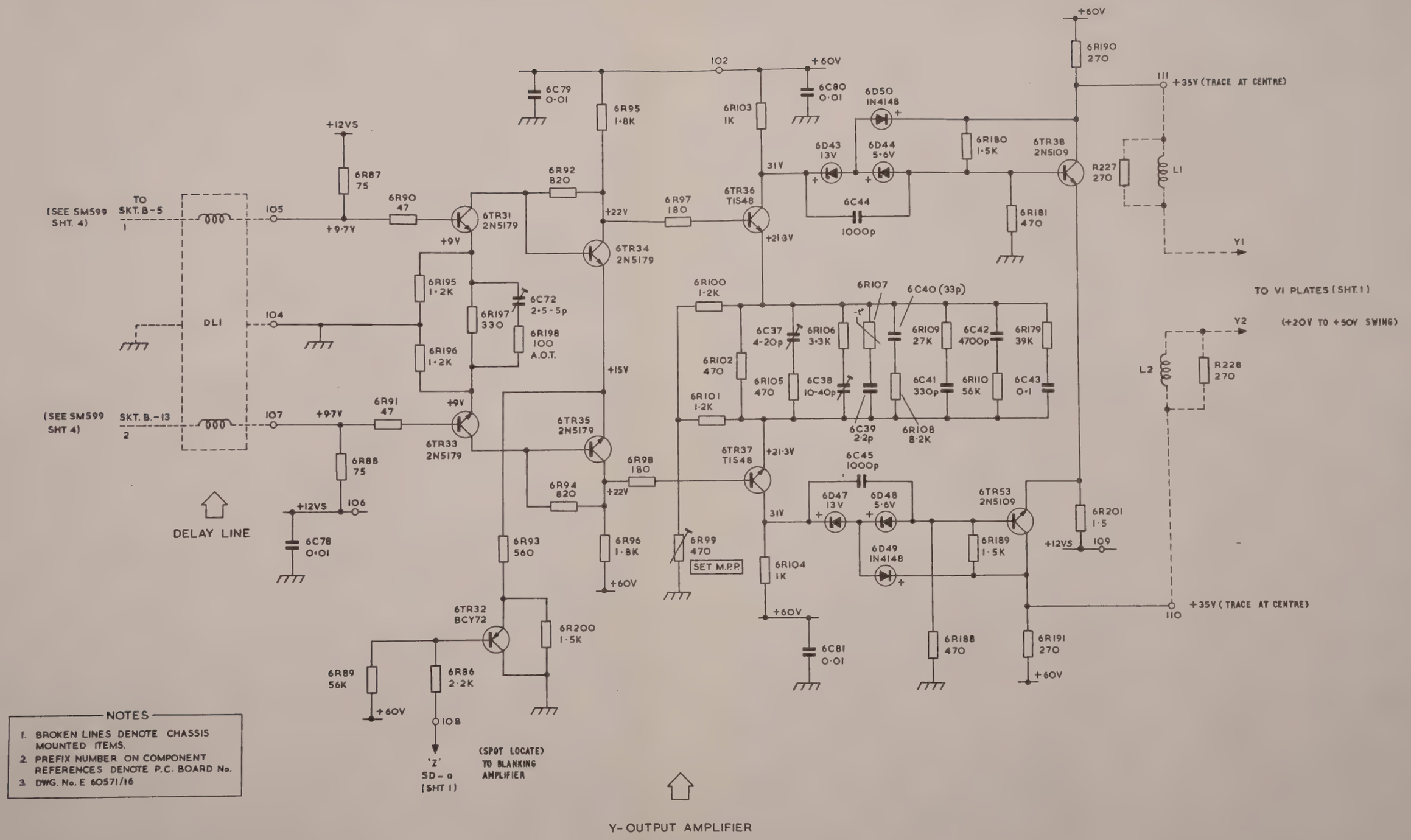
Y-OUTPUT AMPLIFIER BOARD F6

(DWG. No. B 60583)

FIG. 2.10. MAIN FRAME SM112

BOARD LAYOUTS (SHT 2)

CM 1002

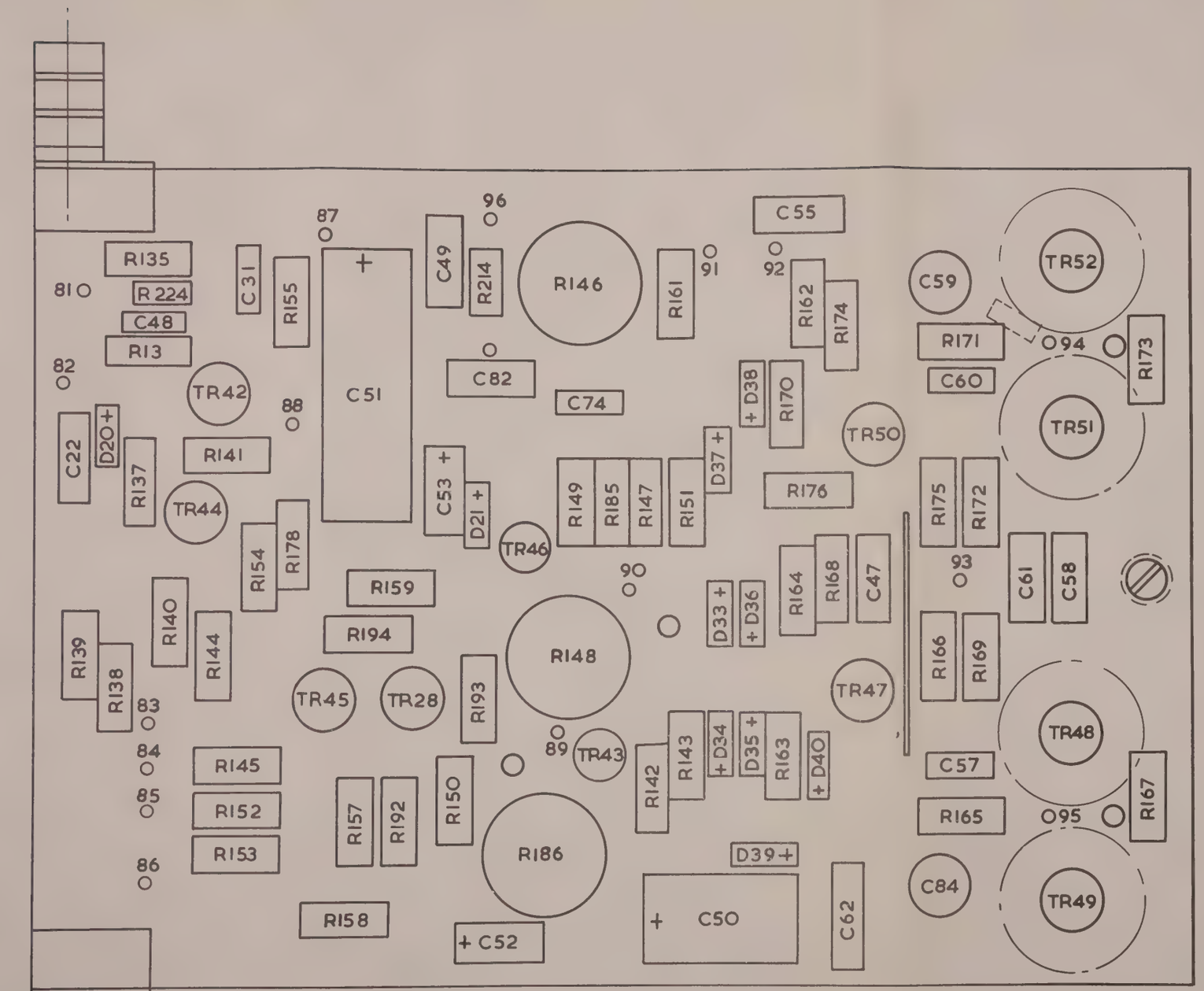


NOTES

1. BROKEN LINES DENOTE CHASSIS MOUNTED ITEMS.
2. PREFIX NUMBER ON COMPONENT REFERENCES DENOTE P.C. BOARD No.
3. DWG. No. E 60571/16

CM 1002

FIG 2.11. MAIN FRAME SM112
CIRCUIT DIAGRAM (SHT 2)
Y OUTPUT AMPLIFIER

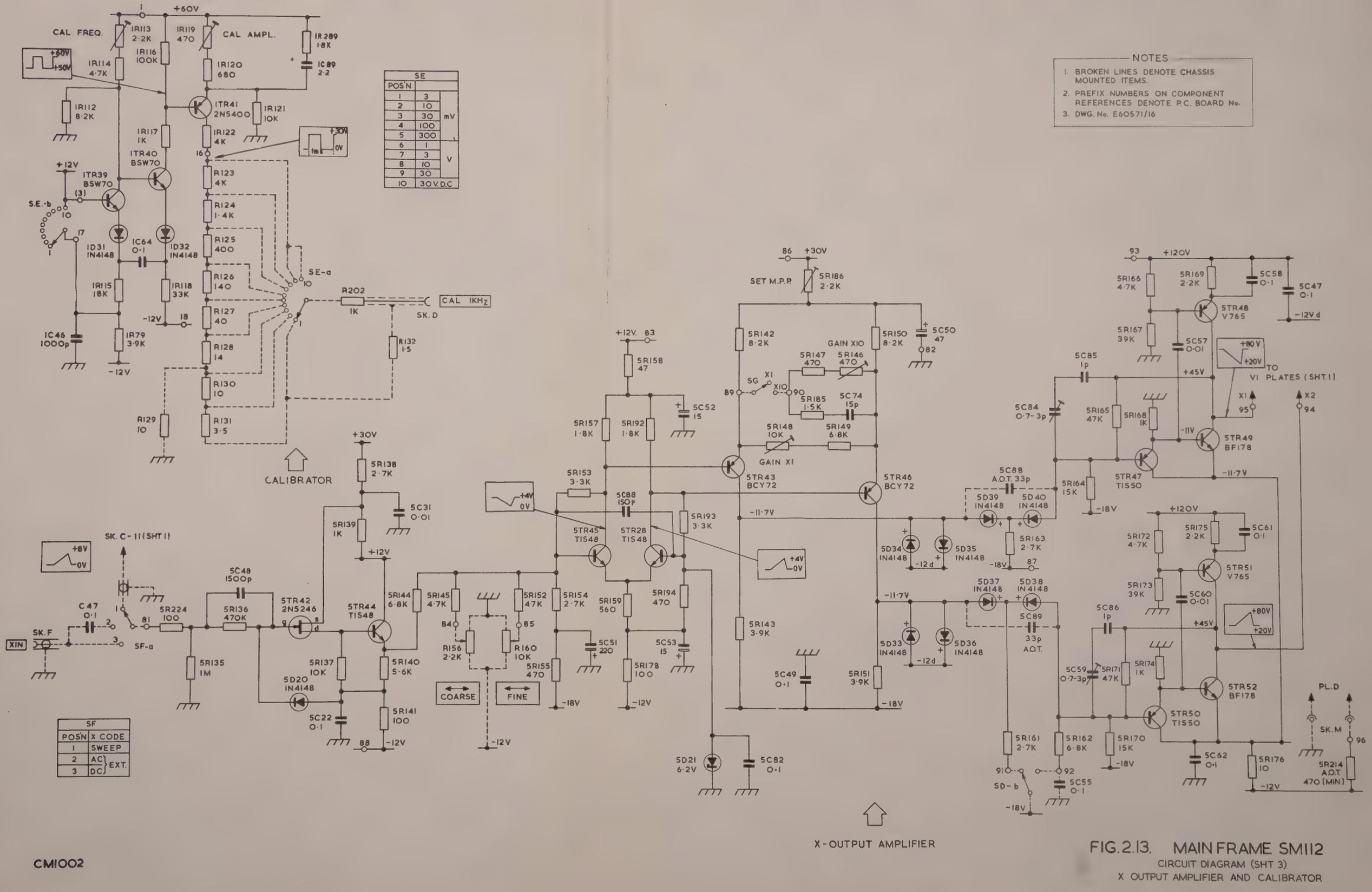


X-OUTPUT AMPLIFIER BOARD F5

(DWG. No. D 60581)

FIG. 2.12 MAIN FRAME SM112
BOARD LAYOUTS (SHT. 3)

CM1002



NOTES

1. BROKEN LINES DENOTE CHASSIS MOUNTED ITEMS.
2. PREFIX NUMBERS ON COMPONENT REFERENCES DENOTE P.C. BOARD No.
3. DWG. No. E60571/16

CM1002

FIG. 2.13. MAIN FRAME SM112
CIRCUIT DIAGRAM (SHT 3)
X OUTPUT AMPLIFIER AND CALIBRATOR

3.1 - CIRCUIT DESCRIPTION

1. A. SWEEP (FIG. 3.1 AND 3.6)

The A sweep trigger source is selected by switch SA from channel 1 or channel 2 signals, external sources or the line frequency. The chosen trigger signal is passed to switch SB which selects the required coupling mode; i.e. AC, HF REJECT, LF REJECT or DC, by the R-C filter networks associated with the switch.

The trigger coupling circuit feeds an input buffer formed by 1TR1 and 1TR2.

The field-effect transistor 1TR1 provides a high impedance input source and is protected against excessive voltage inputs by 1R6, and the diode network 1D7 to 1D10.

The emitter circuit of 1TR2 is direct-coupled to a long-tailed pair, 1TR7, 1TR8, the circuit of which incorporates the LEVEL controls and the SLOPE polarity switch for setting the triggering point. The collector outputs are coupled, via diodes 1D5, 1D6 to drive a Schmitt trigger circuit.

In turn, the Schmitt trigger circuit, 1TR6, 1TR9, 1TR10, and 1TR11 drives a pulse transformer 1T1, 1R38 and 1C13 forming the 'count-down' network which produces a sub-multiple of the trigger repetition frequency. The transformer is also driven by an auxiliary winding from an auto oscillator circuit which permits free-running of the sweep.

The pulse transformer secondary winding provides signal inputs to the logic bistable circuit 1N1 via the input gate 1N7. These trigger signals are pulses approximately 50 ns wide. (See Fig. 3.2.)

When the bistable logic circuit is reset, the output (6) of 1N1 is at logic 0 and 1D14 is reverse-biased. Consequently, 1TR18 is conducting and clamps the gate of the field-effect transistor 1TR19 to the voltage set by the A SWEEP ZERO control 1R203 via 1TR25 and diode 1D15.

A trigger pulse from the transformer 1T1 'sets' the logic bistable to produce a logic 1 at 1N1 (6). Diode 1D14 is forward-biased and the clamp 1TR18 is cut off. Consequently, 1D15 is reverse-biased and the gate of 1TR19 rises as the timing capacitor charges through the timing resistor to produce the sweep waveform.

Transistors 1TR18 to 1TR22 form a bootstrap generator circuit to provide a linear ramp waveform for the forward sweep. This linearity is achieved because the 'target' voltage for the capacitor increases at the same rate as the charging voltage; i.e., the voltage across the timing resistor remains constant.

At a point determined by the SWEEP LENGTH control, 1R86, the logic bistable is reset via 1TR23 and the logic gate 1N1 (8, 9, 10). Thus the clamp circuit for the gate of 1TR19 is again operative and the sweep output is reduced to zero.

Regardless of further trigger pulses, the sweep remains at zero by the action of the 'hold-off' monostable 1TR24 triggered by the sweep length circuit and the associated R-C network including the HF SYNC control, R91.

The logic bistable is held in the set state by this monostable circuit until, at the end of the monostable pulse, the logic bistable can be reset by the next trigger pulse.

In the absence of trigger pulses from an external source, the auto circuit 1TR15, 1TR16, free-runs. The oscillator frequency is determined by the timing components 1R58, C20, C22 and 1C42.

2. B. SWEEP (FIG. 3.3 AND 3.8)

The B sweep circuit is similar to the A sweep except that it has no independent auto operation.

Delay is achieved by feeding the A sweep from the bootstrap generator into the comparator 1N3 where it is compared with a voltage determined by the setting of the DELAY control R147. When both voltages are equal the comparator switches and starts the B sweep, at the point selected, by resetting the logic bistable 2N4 (1 to 6).

The length of the B sweep is controlled by the blanking logic and not by the amplitude of the sweep. The 'hold-off' circuit is common to both A and B sweeps; the logic element 2N4 (1 to 6) forming the input bistable drives the clamp circuit 2TR65 of the B timebase.

When the PULL FOR GATED switch is operated the B sweep is triggered only by an external signal, via the B trigger source and coupling switches SL-a and SF-ab, and the input buffer field-effect transistor 2TR41.

For the MIXED sweep mode, the A and B sweeps are applied to transistors 2TR59, 2TR60, and combined in the common emitter circuit. The series diodes 2D34, 2D35 compensate for the voltage drop across 2TR59, 2D32 and 2TR60, 2D33. The output across 2R179 is connected to the sweep mode selector switch SJ-a to feed the main frame X-output amplifier via PLA 11. Othe sweep modes for B and A are selected by SJ-a from the respective inputs to the bases of 2TR59 and 2TR60.

Single-shot operation is achieved by the logic bistable circuit 2N2 (1 to 6).

The logic states in the single-shot mode are shown for the various operating conditions in the following truth table.

FUNCTION	PIN	WAIT PERIOD	HOLD-OFF PERIOD AFTER SINGLE SWEEP	POST HOLD-OFF PERIOD	RESET DEPRESSED	PRIMED
	4	0	1	1	0	0
Single-shot and Reset input	5	1	1	1	0	1
Inhibit/Allow A sweep output	6,2,	1	0	0	1	1
and Neon Indication		ON	OFF	OFF	ON	ON
Wait/Hold-off input	1	1	0	1	1	1
	3	0	1	1	0	0

A sweep inhibited

TABLE 3.1 SINGLE-SHOT LOGIC STATES

Blanking for the various sweep selector is achieved by the logic gates 2N2 and 2N6 which feed the emitter followers 2TR62 and 2TR63 respectively. These, in turn, feed the blanking amplifier circuit of the main frame.

The blanking logic gates are controlled by the positions of the sweep mode selector switch SJ. The truth table shows the logic states at the pins of 2N6 during the A sweep for the various sweep modes.

PIN	A only	A marked by B	B delayed by A	Mixed
11	1	1	1	1
12	0	1	0	0
13	1	0	1	1
5	0	0	1	1
6	1	1 (0)	1 (0)	1 (0)
4	0	0 (1)	0 (1)	0 (1)
8	1	1	1	1
9	1	0	0	0
10	0	0 (1)	0 (1)	0 (1)
2	0	1	0	0
3	1	1 (0)	1 (0)	1 (0)
1	0	0 (1)	0 (1)	0 (1)

(States in brackets present during B sweep)

TABLE 3.2 BLANKING LOGIC STATES DURING A SWEEP

1. TEST EQUIPMENT

(a) Constant Amplitude Sinewave Generator (Tektronix 191 or similar).

(b) Oscilloscope Calibrator (Bradley 156 or similar).

(c) BNC T-Connector and short BNC lead.

(d) Multimeter (AVO 8 or similar).

(e) Serviceable Main Frame SM112.

(f) Serviceable Y-Amplifier Module SM599.

(g) Low Voltage 6 V A.C. Supply.

2. PRELIMINARY SETTING-UP OF SWEEP

(a) Connect the unit-under-test (SM602) to a serviceable Y-amplifier SM599, and plug both units into a serviceable SM112 Main Frame. Switch on and allow a warm-up period of at least 5 minutes to elapse.

(b) Set the front panel A sweep LEVEL control and all internal and front panel preset controls to mid-position.

(c) Set:

(i) Sweep Mode Selector to A ONLY.

(ii) A TIME/cm on 20 μs/cm.

(iii) SINGLE SHOT not selected.

(iv) PULL AUTO to AUTO.

(d) Check that a sweep is displayed.

3. A TRIGGER

(a) Obtain a sinewave display of amplitude 6 cm at 50 kHz on channel 1 (CH 1).

(b) Set the A Trigger controls:

(i) Trigger Source to CH 1.

(ii) Coupling Selector to AC.

(c) Set the channel 1 Y-amplifier SHIFT control so that the display is central.

(d) Adjust 1R44 (A Trig Level) so that it is at the centre of the range over which triggering is obtainable. (Adjustment of 1R28 (level centre) may also be necessary to obtain this).

(e) Adjust 1R28 (A Level Centre) so that the trigger point occurs where the sinewave crosses the central Y graticule line.

(f) Check that the operation of the A SLOPE + - switch changes the edge on which the A sweep is triggered and that the + position corresponds to the positive slope of the sinewave and the - position corresponds to the negative slope.

4. MECHANICAL DELAY SETTING

(a) Rotate the DELAY helipot dial fully anti-clockwise. Check that the dial reads 0.3. If necessary loosen the dial on the spindle and re-align it.

5. A SWEEP ZERO

(a) Set the Sweep Mode Selector to A MARKED BY B. Push-in the PULL GATED control.

(b) On the SM112 Main Frame, operate the PULL x 10 control to obtain x 10 gain and adjust the FINE COARSE shift controls to observe the start of the trace.

(c) Adjust the A Sweep Zero potentiometer (1R203) so that the brightened portion starts 3 cm from the start of the trace. If required, adjust the CONTRAST (located under red cap on BRILL control) on SM112 Main Frame.

6. A SWEEP LENGTH

(a) Set the Sweep Mode Selector to A ONLY. Set the PULL x 10 control on the SM112 Main Frame to x 1 (pushed-in).

(b) Set the sweep length to 12 cm by adjusting the A Sweep Length potentiometer (1R86).

7. A SWEEP RATE

(a) Set the TIME/cm Var Control to CAL. Check CAL indicator lights up. Position the SET (cal) preset control (located underneath the red cap on the TIME/cm Var Control) to mid-position.

(b) Connect the Oscilloscope Calibrator to the Y-amplifier Module SM599. Set the A TIME/cm switch and output period of the Oscilloscope Calibrator to the positions shown below, and adjust the relevant potentiometer (on the small A sweep board) to display the number of markers/cm shown. With all adjustments, maintain a vertical display amplitude of about 5 cm, using the V/cm controls on the Y-amplifier Module SM599.

A TIME/cm Setting	Oscilloscope Calibrator Period Setting/cm	Adjust	Markers/cm
1 µs	0.2 µs	R76(0.05 µs-1 µs)	1
10 µs	10 µs	R77(2 µs-0.1 ms)	1
1 ms	1 ms	R78(0.2 ms-10 ms)	1
0.1 s	0.1 s	R79(20 ms-1 s)	1

(c) Select each position of the A TIME/cm switch in turn and set the output of the Oscilloscope Calibrator to give the corresponding period/cm. Check that 1 marker/cm is displayed on each position, and that each range is to within 2% (measured over the centre 8 cm).

8. DELAY CALIBRATION

(a) Position the start of the trace on the first vertical graticule line. Set the Sweep Mode Selector to A MARKED BY B. Rotate the DELAY helipot to the fully clockwise (10.3) position.

(b) Adjust the Delay Cal preset potentiometer (1R146) so that the brightened portion of the trace coincides with the last vertical graticule line.

(c) Check that for each turn of the DELAY helipot, the brightened portion of the trace moves by 1 cm ± 1 mm.

9. A SWEEP H.F. REJECT

(a) Set the Sweep Mode Selector to A ONLY. Connect the Constant Amplitude Sinewave Generator, to CH 1 IN on Y-amplifier Module SM599. Set channel 1 V/cm to 0.01 V/cm.

(b) Set the output of the Constant Amplitude Sinewave Generator to 50 mV r.m.s. at 350 kHz.

(c) On the Timebase Module SM602, set the A trigger coupling selector to HF REJ and the A TIME/cm switch to 2 µs/cm. Check that triggering, using the A LEVEL control is now almost impossible.

10. A SWEEP, AC AND DC INPUT COUPLING

(a) Set the A Input Coupling Selector to DC. Connect the Constant Amplitude Sinewave Generator as in Para. 9, A Sweep HF Reject.

(b) Check that, when the CH 1 SHIFT control on the Y-amplifier Module is rotated, the trigger point of the A sweep moves along the curve of the sinewave.

(c) Switch the Input Coupling Selector to AC. Rotate the CH 1 SHIFT control on the Y-amplifier Module and check that the trigger point remains stationary.

11. A LEVEL FUNCTION

(a) Connect the Constant Amplitude Sinewave Generator as detailed above, but with the amplitude set to display over the full screen, and reduce the frequency to 50 kHz.

(b) Switch the Input Coupling Selector to AC and check that it is possible to trigger to within 5 mm of the top and bottom of the sinewave, with the SLOPE + - selector at either position using the A LEVEL control.

12. A INPUT COUPLING AND LINE TRIGGERING

(a) Disconnect the Constant Amplitude Sinewave Generator and connect in its place (to CH 1 IN on Y-amplifier Module) the Test Low Voltage Supply. Adjust the V/cm controls on the Y-amplifier Module to obtain a display of about 6 cm.

(b) Set the A Trigger Source Selector to LINE. Check that triggering is normal in the AC, DC and HF REJ positions of the A Input Coupling Selector, but is very difficult (or impossible) in the LF REJ position.

13. A TIME/CM VAR FUNCTION

(a) Set the A Input Coupling Selector to AC. Set the A TIME/cm to 5 ms position. One cycle should occupy 4 cm.

(b) Check that, when the TIME/cm Var control is rotated fully anti-clockwise, one cycle is less than 1.6 cm. Disconnect the Test Low Voltage Supply.

14. A TRIGGERING ON CHANNEL 2

(a) Set the A Trigger Source Selector to CH2. Connect the Constant Amplitude Sinewave Generator (Set to 50 kHz) to CH2 IN of the Y-amplifier Module. Adjust the V/cm controls and generator output to obtain a display of about 5 cm.

(b) Check that triggering is normal using the A LEVEL control.

15. A EXTERNAL TRIGGERING

(a) Using the T-connector, connect the Constant Amplitude Sinewave Generator signal to CH2 (as Para. 14) on the Y-amplifier Module and to the A TRIG IN connector on the Timebase Module.

(b) Increase the output to 5 V r.m.s. and switch the Trigger Source Selector to EXT. Adjust the CH2 V/cm controls to display a waveform about 5 cm high. Deselect AUTO (push-in PULL AUTO) and adjust the A LEVEL control for a stable trace.

(c) Set the Trigger Source Selector to EXT ÷ 10 and check that the trigger range of the A LEVEL control is considerably reduced.

16. SINGLE SHOT FUNCTION

(a) With the oscilloscope set as in Para. 15 above, rotate the A LEVEL control fully anti-clockwise and set the A TIME/cm control to 50 ms/cm.

(b) Rotate the SINGLE SHOT/HF SYNC control to SINGLE SHOT. Press the RESET push-button and check that the SINGLE SHOT indicator lights up.

(c) Rotate the A LEVEL control clockwise and check that only one sweep occurs, at the end of which the SINGLE SHOT indicator is extinguished.

(d) Disconnect the signal from the A TRIG IN connector and rotate the SINGLE SHOT/HF SYNC control away from the SINGLE SHOT position.

17. B SWEEP ZERO

(a) Rotate the DELAY helipot and B Sweep Zero potentiometer (2R163) fully anti-clockwise, and set the Sweep Mode Selector to A ONLY. Set the A TIME/cm selector to 0.1 ms/cm range.

(b) Position the start of the trace in the centre of the graticule.

(c) Connect 50 kHz generator to Y input and obtain a stable display.

(d) Set the Sweep Mode Selector to MIXED and adjust the B Sweep Zero potentiometer (2R163) to just eliminate cramping.

(e) Check that with Selector in B DELAYED BY A position, the trace start is displaced to the left of centre by between 0 and 5 mm.

18. B SWEEP LENGTH

(a) Set the B TIME/cm switch to 1 µs/cm, with the A TIME/cm switch on 10 µs/cm.

(b) Adjust the B Sweep Length potentiometer (2R182) for a sweep length of 11 cm.

(c) Set the B TIME/cm switch to the locked position.

19. B SWEEP RATE

(a) Set the TIME/cm Var Control to CAL. Check CAL indicator lights up. Position the SET (Cal) preset control (located underneath red cap on the TIME/cm Var control) to mid-position.

(b) Connect the Oscilloscope Calibrator to the Y-amplifier Module. Set the B TIME/cm switch and the output period of the Oscilloscope Calibrator to the positions shown below, and adjust the relevant potentiometer (on the small B Sweep Board) to display the number of markers/cm shown. With all adjustments, maintain a vertical amplitude of about 5 cm, using the V/cm controls on the Y-amplifier Module.

B TIME/cm Setting	Oscilloscope Calibrator Period Setting/cm	Adjust	Markers/cm
1 µs	0.2 µs	R170(0.05µs-1µs)	1
10µs	10 µs	R171(2µs-0.1ms)	1
1 ms	1 ms	R172(0.2ms-10ms)	1
0.1 s	0.1 s	R173(20ms-1s)	1

(c) Select each position of the B TIME/cm switch in turn and set the output of the Oscilloscope Calibrator to give the corresponding period/cm. Check that 1 marker/cm is displayed on each position and that each range is to within 2% measured over the centre 8 cm.

20. B TRIGGER

(a) Set the B LEVEL control to mid-position. Set the B Trigger Source Selector to CH 1, and the B Input Coupling Selector to AC.

(b) Set the DELAY helipot to approximately mid-position.

(c) Set the A Trigger Source Selector to CH 1 and the A Input Coupling Selector to AC.

(d) Set the Sweep Mode Selector to A MARKED BY B and the A TIME/cm switch to 10 µs/cm.

(e) Connect the Constant Amplitude Sinewave Generator (set to 50 kHz) to CH 1 IN on the Y-amplifier Module. Adjust the V/cm controls on the Y-amplifier Module to obtain a display of 6 cm, 3 cm either side of the Y graticule centre-line.

(f) Stabilise the display, using the A LEVEL control, to give a sinewave with a brightened portion on the right of the screen.

(g) Pull out the PULL GATED control (to select gated mode), the brightened portion of the trace may reduce in intensity. Adjust the B trigger level potentiometer (2R144) to the centre of the range over which a stable brightened portion is displayed.

(h) Adjust the B Level Centre potentiometer (2R128) so that the trigger point occurs where the sinewave crosses the central Y graticule line.

(j) Check that operation of the B SLOPE + - switch changes the edge on which the B sweep is triggered and that the + position corresponds to the positive slope of the sinewave, and the - position corresponds to the negative slope.

21. B SWEEP AND DC INPUT COUPLING

(a) Set the B Input Coupling Selector to DC.

(b) Check that, when the CH 1 SHIFT control on the Y-amplifier Module is rotated, the trigger point of the B sweep moves along the curve of the sinewave.

(c) Set the B Input Coupling Selector to AC. Rotate the CH 1 SHIFT control on the Y-amplifier Module and check that the trigger point remains stationary.

22. B GATED FUNCTION

(a) Rotate the DELAY helipot and check that the start of the B sweep jumps along the sinewave in steps, one step for every two-turns of the DELAY helipot.

23. B DELAYED BY A FUNCTION

(a) Set the Sweep Mode Selector to B DELAYED BY A.

(b) Push in the PULL GATED control.

(c) Check that clockwise rotation of the DELAY helipot moves the displayed sinewave smoothly to the left.

(d) Pull-out the PULL GATED control.

24. B SWEEP HF REJECT

(a) Rotate the DELAY helipot fully anti-clockwise. Increase the frequency of Constant Amplitude Sinewave Generator output to 350 kHz, and set the A TIME/cm switch to 2 μs/cm.

(b) Set the B Input Coupling Selector to HF REJ. Check that triggering the B sweep, using the B LEVEL control, is now almost impossible.

25. B LEVEL FUNCTION

(a) Set the B Input Coupling Selector to AC. Increase the input signal to give a full screen display, and reduce the frequency to 50 kHz.

(b) Check that it is possible to trigger to within 5 mm of the top and bottom of the sinewave on either position of the B SLOPE + - switch, using the B LEVEL Control.

26. B EXTERNAL TRIGGERING

(a) Disconnect the Constant Amplitude Sinewave Generator from CH 1 IN, insert the T-connector, and re-connect one side to CH 1 IN. Connect the other side to the B TRIG IN connector on the Timebase Module.

(b) Increase the signal to 5 V r.m.s. and adjust the V/cm controls on the Y-amplifier Module to obtain a display of 5 cm.

(c) Set the B Trigger Source Selector to EXT and check that it is possible to obtain a stable display.

(d) Set the B Trigger Source Selector to EXT ÷ 10, and check that the triggering range of the B LEVEL control is greatly reduced.

27. MIXED MODE OPERATION

(a) Set the B Trigger Source Selector to EXT, and the Sweep Mode Selector to MIXED.

(b) Pull out and rotate the B SWEEP (B TIME/cm) control to the 0.2 μs/cm position.

(c) Rotate the DELAY control to approximately 5.0. Check that both sweep speeds are visible.

(d) Remove all signals and rotate the DELAY helipot fully anti-clockwise. Rotate the B TIME/cm control until it locks with the A TIME/cm control.

1. INTRODUCTION

This section contains information on the maintenance of the timebase module SM602. Routine maintenance and cleaning should be carried out preferably before the alignment procedures already detailed. After replacement of components, re-calibration of the associated circuits must be carried out in accordance with the procedures outlined.

2. ACCESSIBILITY (FIG. 3.5 AND 3.7)

Two press-and-turn fasteners on the side panel of the unit provide for integral mounting with the SM599 or a similar unit. These are accessible by means of a long-shafted screwdriver after hinging outwards the B sweep board which is secured by two screws at its lower edge. The A sweep board at the base of the unit is also released by these screws.

Hinging the A and B sweep boards provides unrestricted access to the Time/cm switches and their associated timing controls and components.

After maintenance, ensure that all retaining screws are secured.

3. PREVENTIVE MAINTENANCE

A preventive maintenance routine includes cleaning, visual inspection and lubrication and if performed periodically, can prevent breakdown. The frequency of maintenance is determined by the environment to which the unit is subjected: the ideal time for a routine maintenance check is immediately preceding recalibration.

3.1 CLEANING

Due to its heat-insulating effect on components, dust accumulation within the unit reduces heat dissipation and can cause breakdown.

A dry low-velocity air line is recommended for removing dust, a small brush being particularly useful for dislodging dirt in inaccessible places such as switch wafers and on or under front panel controls.

3.2 VISUAL INSPECTION

Periodically inspect the unit for mechanical defects (e.g. on rotary switches or support brackets), for broken connections, including the printed wiring on the circuit cards, and for evidence of overheated components.

The occasional use of an approved lubricant (one that does not affect electrical or mechanical characteristics) can help to maintain the reliability of moving parts (e.g. rotary switches and potentiometers). Do not over-lubricate. Panclimatic grease

should be used to lubricate concentric shafts.

4. REMOVAL OF FRONT-PANEL CONTROL KNOBS

The DELAY helipot control knob can be removed after releasing the Allen screw.

All other rotary control knobs can be removed by first prising off the centre cap and then unscrewing the retaining screw or hexagonal nut.

The knobs for the slider switches are of the pull-off type.

1. INTRODUCTION

This section contains information for ordering replaceable parts. The tables provide the following information:

(a) Circuit Reference.

(b) Value, Tolerance and rating (where applicable).

(c) Manufacturer/Reference.

(d) SEL Part No.

Minor items, such as screws, nuts, etc., have not been included as they are not considered special to the equipment.

2. ORDERING INFORMATION

To order your replacement parts, address the order to your local agent or to S.E. LABORATORIES (ENGINEERING) LTD. SERVICE DEPARTMENT, NORTH FELTHAM TRADING ESTATE, FELTHAM, MIDDLESEX, ENGLAND.
Telephone No. 01-890-1166/5876.

Specify the following information for each part:

(a) Model and serial number of the equipment.

(b) SEL part number, and manufacturer's reference.

(c) Circuit reference.

(d) Description (i.e. Value, Tolerance and rating).

To order a part not listed, give the part number, description of the major assembly which is listed, and a complete description of the part required.

The assemblies are listed as follows:

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Sub-Assemblies			
	B60649	Card 1, 'A' Sweep Assembly			
	B60651	Card 2, 'B' Sweep Assembly			
		Capacitors (fixed) µF			
C1	CS30467	Erie XD/P100	1 p	±0.25p	750 V
C2	CS30218	Erie 831/N3300	100p	20	500 V
C3	CS30362	Erie 801/K800011	0.01	+80 -20	500 V
C4	CS30218	Erie 831/N3300	100p	20	500 V
C20		Mullard 015-15159	15	+50 -10	16 V
C22	CS30990	Mullard C280AE/A470K	0.47	10	250 V
C25	CS30474	Suflex HS	430p	5	160 V
C26	CS30476	Mullard C295AA/D47K	0.047	1	125 V
C27	CS31027	Advance MD40	4.7	10	63 V
C33		Mullard 015-15159	15	+50 -10	16 V
C34		Mullard 015-18228	2.2	+50 -10	63 V
C35	CS30626	Mullard C280AE/P22K	0.022	20	250 V
C36	CS30461	Erie 831/K7004	2200p	20	500 V
C38	CS30449	Erie 831/K120051	470p	20	500 V
C41	CS30489	Mullard C280AE/P220K	0.22	20	250 V
C51	CS30467	Erie XD/P100	1 p	±0.25p	750 V
C52	CS30218	Erie 831/N3300	100p	20	500 V
C53	CS30362	Erie 801/K800011	0.01	+80 -20	500 V
C54	CS30218	Erie 831/N3300	100p	20	500 V
C68	CS30474	Suflex HS	430p	5	160 V
C69	CS30476	Mullard C295AA/D47K	0.047	1	125 V
C70	CS31027	Advance MD40	4.7	10	63 V
C82	CS30362	Erie 801/K800011	0.01	+80 -20	500 V
C83	CS30362	Erie 801/K800011	0.01	+80 -20	500 V
C84		Mullard 016-14101	100	+50 -10	10 V
C85		Mullard 016-14101	100	+50 -10	10 V
C86	CS30218	Erie 831/N3300	100p	20	500 V
C87	CS30218	Erie 831/N3300	100p	20	500 V

Cct. Ref.	SEL Part No.	Manufacturer/ Reference	Value	Tol. ± %	Rating
		Resistors (fixed) Ω			
R2	DS32366	Electrosil TR5	100k	2	½
R3	DS33852	Morganite, type S	2.2M	10	½
R4	DS32835	Electrosil TR5	270k	2	½
R63	DS33923	Welwyn 4034/G	2.43M	1	
R64	DS33922	Welwyn 4034/G	1.21M	1	
R65	DS33921	Welwyn 4034/G	487k	1	
R66	DS33920	Welwyn 4034/G	243k	1	
R67	DS33919	Welwyn 4034/G	121k	1	
R68	DS33918	Welwyn 4034/G	48.7k	1	
R69	DS33917	Mullard MR30	24.3k	1	
R70	DS33916	Mullard MR30	12.1k	1	
R92	CS32359	Electrosil TR5	4.7k	2	½W
R102	DS32366	Electrosil TR5	100k	2	½
R103	DS33852	Morganite, type S	2.2M	10	½
R104	DS32835	Electrosil TR5	270k	2	½
R154	DS33923	Welwyn 4034/G	2.43M	1	
R155	DS33922	Welwyn 4034/G	1.21M	1	
R156	DS33921	Welwyn 4034/G	487k	1	
R157	DS33920	Welwyn 4034/G	243k	1	
R158	DS33919	Welwyn 4034/G	121k	1	
R159	DS33918	Welwyn 4034/G	48.7k	1	
R160	DS33917	Mullard MR30	24.3k	1	
R161	DS33916	Mullard MR30	12.1k	1	
R199	DS32366	Electrosil TR5	100k	2	½
R206	DS32366	Electrosil TR5	100k	2	½
R212	DS6192 or	Dubilier BTT	470k	10	½W
	DS6248	Dubilier BTT	1 M	10	½W
R214	DS6138 or	Dubilier BTT	220k	10	½W
	DS6167 or	Dubilier BTT	330k	10	½W
	DS6192	Dubilier BTT	470k	10	½W
R216	DS33722	Mullard MR25	47	2	
R217	DS33722	Mullard MR25	47	2	

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R219	DS32374	Mullard MR25	8.2k	2	½ W
R224	DS32152	Electrosil TR5	150k	2	½ W
R225	DS32234	Electrosil TR5	47	2	½ W
R226	DS32234	Electrosil TR5	47	2	½ W
R230	DS6192 or	Dubilier BTT	470k	10	½ W
	DS6248	Dubilier BTT	1 M	10	½ W
R231	DS6138 or	Dubilier BTT	220k	10	½ W
	DS6167 or	Dubilier BTT	330k	10	½ W
	DS6192	Dubilier BTT	470k	10	½ W
		Resistors (variable) Ω			
R30 + SD	DS60767	AB Electronic Components IC-45	10k		
R76	DS33867	Erie 80P/2	22k	20	¼ W
R77	DS33867	Erie 80P/2	22k	20	¼ W
R78	DS33867	Erie 80P/2	22k	20	¼ W
R79	DS33867	Erie 80P/2	22k	20	¼ W
R82	DS33847	AB Electronic Components C2-45	1 k		
R83			4.7k		
R91 + SC	DS60768	AB Electronic Components 44 S	4.7k		
R130 + SD	DS60767	AB Electronic Components IC-45	10k		
R147	FS10376	Reliance HEL07-10	1k		
R170	DS33867	Erie 80P/2	22k	20	¼ W
R171	DS33867	Erie 80P/2	22k	20	¼ W
R172	DS33867	Erie 80P/2	22 k	20	¼ W
R173	DS33867	Erie 80P/2	22k	20	¼ W
		Miscellaneous			
ILP1		Neon, Osmor, 250/1/Red			
ILP2		Neon, Osmor, 250/1/Red			
PLA	AS0585	Plug, McMurdo RP16			
SKA	AS1469	Socket (Greenpar)BNG GE35026	50Ω		

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
SKB	AS1469	Socket (Greenpar) BNG GE35026	50Ω		
SA	D60568	Switch (Trig.Sel.A and B)			
SB	D60661	Switch, Lever			
SC	DS60768	AB Electronic Components 44S	4.7k		
SD	DS60767	AB Electronic Components IC-45	10k		
SE	D60598	Switch(Time/cm)			
SF	D60661	Switch, Lever			
SG	DS60767	AB Electronic Components IC-45	10k		
SH	D60598	Switch (Time/cm)			
SJ	D60683	Switch (Sweep Mode)			
SK	QS22040	Switch, Push-button, Rendar PBS-1-M			
SL	D60568	Switch (Trig.Sel.A and B)			
SM	D60682	Switch, Lever (slope)			
SN	D60682	Switch, Lever (slope)			
	GS11167	Transformer, Mullard FX3007			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Capacitors (fixed) µF			
C5	CS30995	Erie 831/K120051, type 2	470p	20	500 V
C6	CS30958	Erie 831/K350081, type 2	1000p	20	500 V
C7	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C8	CS30951	Mullard C380AE/P100K/040	0.1	20	250 V
C9	CS30951	Mullard C380AE/P100K/040	0.1	20	250 V
C10	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
C11	CS30951	Mullard C380AE/P100K/040	0.1	20	250 V
C12	CS30951	Mullard C380AE/P100K/040	0.1	20	250 V
C13	CS31003	Erie 831/N2200	68 p	20	500 V
C14	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
C16	CS30958	Erie 831/K350081, type 2	1000p	20	500 V
C18	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
C19		Erie 831/N4200	220p	20	500 V
C23	CS30958	Erie 831/K350081, type 2	1000p	20	500 V
C24	CS31061	Erie 831/NPO	10 p	20	500 V
C28	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C29	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C30		Mullard 015-15159	15	+50 -10	16 V
C31	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C32		Erie 831/N750	33p	20	500 V
C37	CS30995	Erie 831/K120051, type 2	470 p	20	500 V
C39		Erie 831/N4200	220p	20	500 V
C42	CS31002	Erie 831/K7004, type 2	3300 p	+40 -20	500 V
C43		Mullard 015-15159	15	+50 -10	16 V
C75		Mullard 015-15159	15	+50 -10	16 V
C77	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
C78	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
C81	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
		Diodes			
D3	BS2542	STC, 1N4148			
D4	BS2542	STC, 1N4148			
D5	BS2542	STC, 1N4148			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
D6	BS2542	STC 1N4148			
D7	BS2542	STC 1N4148			
D8	BS2542	STC 1N4148			
D9	BS2543	Mullard BZY88/C4V7			
D10	BS2941	Mullard BZY88/C3V3			
D11	BS2542	STC 1N4148			
D12	BS2542	STC 1N4148			
D13	BS2525	Mullard BZY88/C6V2			
D14		Mullard BZY88/C5V1			
D38		Mullard BZY88/C5V1			
		Resistors (fixed) Ω			
R5	DS33852	Morganite type S	2.2M	10	½ W
R6	DS32439	Electrosil TR5	220k	2	½ W
R7	DS32234	Electrosil TR5	47	2	½ W
R9	DS7479	Electrosil TR5	1 k	2	½ W
R10	DS32362	Electrosil TR5	3.3k	2	½ W
R11	DS32234	Electrosil TR5	47	2	½ W
R12	DS32364	Electrosil TR5	220	2	½ W
R13	DS7479	Electrosil TR5	1 k	2	½ W
R17	DS32357	Electrosil TR5	1.5k	2	½ W
R18	DS32234	Electrosil TR5	47	2	½ W
R23	DS32362	Electrosil TR5	3.3k	2	½ W
R24	DS32362	Electrosil TR5	3.3k	2	½ W
R25	DS32234	Electrosil TR5	47	2	½ W
R26	DS32126	Electrosil TR5	390	2	½ W
R27	DS32357	Electrosil TR5	1.5k	2	½ W
R29	DS32127	Electrosil TR5	470	2	½ W
R31	DS32356	Electrosil TR5	180	2	½ W
R32	DS7302	Electrosil TR5	10	2	½ W
R33	DS32356	Electrosil TR5	180	2	½ W
R34	DS32128	Electrosil TR5	330	2	½ W
R35	DS32131	Electrosil TR5	2.2k	2	½ W
R36	DS32383	Electrosil TR5	560	2	½ W

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R37	DS32234	Electrosil TR5	47	2	½ W
R38	DS7491	Electrosil TR5	1.2k	2	½ W
R42	DS32127	Electrosil TR5	470	2	½ W
R43	DS7526	Electrosil TR5	10k	2	½ W
R45	DS32131	Electrosil TR5	2.2k	2	½ W
R52	DS32131	Electrosil TR5	2.2k	2	½ W
R53	DS7479	Electrosil TR5	1k	2	½ W
R54	DS7479	Electrosil TR5	1 k	2	½ W
R55	DS7479	Electrosil TR5	1 k	2	½ W
R56	DS32370	Electrosil TR5	33 k	2	½ W
R57	DS32368	Electrosil TR5	6.8k	2	½ W
R58	DS7526	Electrosil TR5	10k	2	½ W
R59	DS32361	Electrosil TR5	100	2	½ W
R61	DS32367	Electrosil TR5	820	2	½ W
R62	DS32131	Electrosil TR5	2.2k	2	½ W
R71	DS32360	Electrosil TR5	47k	2	½ W
R72	DS32360	Electrosil TR5	47 k	2	½ W
R73	DS32359	Electrosil TR5	47k	2	½ W
R74	DS7302	Electrosil TR5	10	2	½ W
R75	DS32440	Electrosil TR5	15k	2	½ W
R80	DS32376	Electrosil TR5	27k	2	½ W
R81	DS32440	Electrosil TR5	15k	2	½ W
R84	DS7479	Electrosil TR5	1 k	2	½ W
R85	DS32234	Electrosil TR5	47	2	½ W
R87	DS32126	Electrosil TR5	390	2	½ W
R88	DS32131	Electrosil TR5	2.2k	2	½ W
R89	DS32368	Electrosil TR5	6.8k	2	½ W
R90	DS7479	Electrosil TR5	1 k	2	½ W
R93	DS32440	Electrosil TR5	15k	2	½ W
R94	DS32375	Electrosil TR5	1.8k	2	½ W
R95	DS32361	Electrosil TR5	100	2	½ W
R96	DS32234	Electrosil TR5	47	2	½ W
R97	DS7479	Electrosil TR5	1 k	2	½ W
R98	DS32409	Electrosil TR5	3.9k	2	½ W

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R99	DS7526	Electrosil TR5	10 k	2	½ W
R100	DS32364	Electrosil TR5	220	2	½ W
R107	DS32365	Electrosil TR5	270	2	½ W
R148	DS32358	Electrosil TR5	680	2	½ W
R149	DS7479	Electrosil TR5	1 k	2	½ W
R150	DS32131	Electrosil TR5	2.2k	2	½ W
R151	DS32131	Electrosil TR5	2.2k	2	½ W
R152	DS32132	Electrosil TR5	2.7k	2	½ W
R153	DS33864	Electrosil TR5	330k	2	½ W
R201	DS32356	Electrosil TR5	180	2	½ W
R202	DS32357	Electrosil TR5	1.5k	2	½ W
R204	DS32131	Electrosil TR5	2.2k	2	½ W
R205	DS32357	Electrosil TR5	1.5k	2	½ W
R207	DS32234	Electrosil TR5	47	2	½ W
R208	DS32361	Electrosil TR5	100	2	½ W
R213	DS7526	Electrosil TR5	10 k	2	½ W
R218	DS32385	Electrosil TR5	150	2	½ W
R221	DS32361	Electrosil TR5	100	2	½ W
R223	DS32234	Electrosil TR5	47	2	½ W
R228	DS32358	Electrosil TR5	680	2	½ W
		Resistors (variable)			
R28	FS10250	Plessey, MP/PC Dealer LIN (or Erie 80P-2)	10 k	20	¼ W
R44	FS10299	Plessey, MP/PC Dealer LIN	1 k	20	¼ W
R86	FS10353	Plessey, MP/PC Dealer LIN	220	20	¼ W
R146	FS10353	Plessey, MP/PC Dealer LIN	220	20	¼ W
R203	FS10299	Plessey, MP/PC Dealer LIN	1 k	20	¼ W
		Transistors			
TR1	BS2938	Texas 2N5245			
TR2	BS2756	Texas TIS 48			
TR6	BS2756	Texas TIS 48			
TR7	BS2939	Texas BF357K			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
TR8	BS2939	Texas BF357K			
TR9	BS2835	R.C.A. 2N5179			
TR10	BS2835	R.C.A. 2N5179			
TR11	BS2835	R.C.A. 2N5179			
TR13	BS2949	Fairchild 2N5139			
TR15	BS2756	Texas TIS 48			
TR16	BS2756	Texas TIS 48			
TR18	BS2832	Mullard BC148			
TR19	BS2758	Texas 2N5246			
TR20	BS2949	Fairchild 2N5139			
TR21	BS2832	Mullard BC148			
TR22	BS2519	Mullard BCY72			
TR23	BS2756	Texas TIS 48			
TR24	BS2756	Texas TIS 48			
TR25	BS2519	Mullard BCY72			
		Miscellaneous			
N1	BS2550	Integrated Circuit, Texas SN7400N			
N3	BS2705	Integrated Circuit, Texas SN72710N			
N7	BS2940	Integrated Circuit, Texas SN7410N			
T1	C6068I/01	Transformer, S.E.L.			

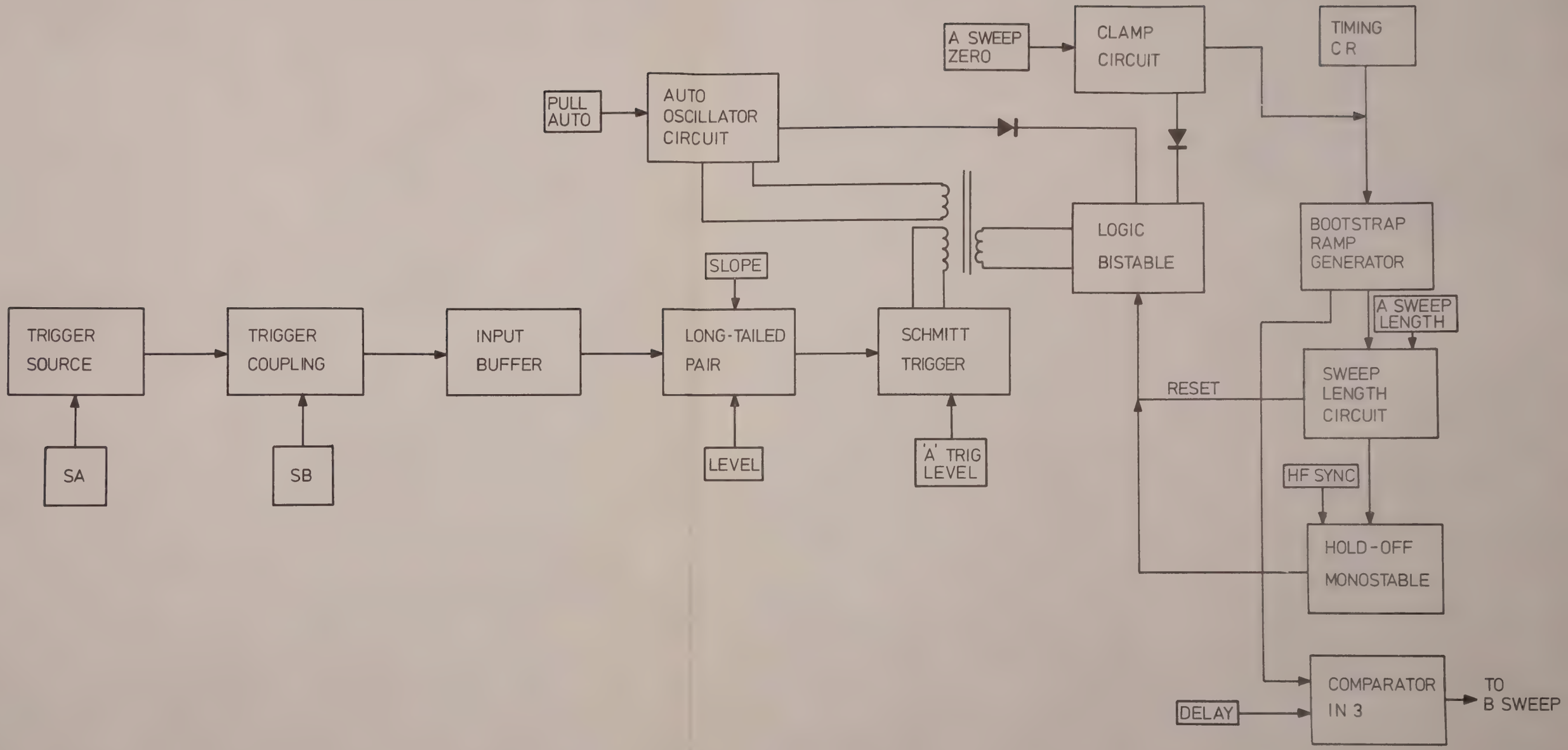
Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Capacitors (fixed) µF			
C17	CS30958	Erie 831/K350081, type 2	1000p	20	500 V
C40	CS30958	Erie 831/K350081, type 2	1000p	20	500 V
C44		Mullard 015-13339	33	+50 -10	6.3 V
C45	CS30954	Erie 801/K800011	0.01	+80 -20	500 V
C46	CS30954	Erie 801/K800011	0.01	+80 -20	500 V
C55	CS30995	Erie 831/K120051, type 2	470p	20	500 V
C56	CS30958	Erie 831/K350081, type 2	1000p	20	500 V
C57	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C58	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C59	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C60	CS30954	Erie 801/K800011	0.01	+80 -20	500 V
C61	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C62	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C63	CS30998	Erie 831/W4200	220p	20	500 V
C64	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C65	CS30958	Erie 831/K350081, type 2	1000p	20	500 V
C67	CS31000	Erie 831/N220	22p	20	500 V
C71	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C72	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C73		Mullard 015-15159	15	+50 -10	16 V
C74	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C75	CS30958	Erie 831/K350081, type 2	1000p	20	500 V
C76		Mullard 015-15159	15	+50 -10	16 V
C79	CS30954	Erie 801/K800011	0.01	+80 -20	500 V
C80	CS30954	Erie 801/K800011	0.01	+80 -20	500 V
		Diodes			
D18	BS2542	STC 1N4148			
D23	BS2542	STC 1N4148			
D24	BS2542	STC 1N4148			
D25	BS2542	STC 1N4148			
D26	BS2542	STC 1N4148			
D27	BS2542	STC 1N4148			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
D28	BS2542	STC 1N4148			
D29	BS2543	Mullard BZY88/C4V7			
D30	BS2941	Mullard BZY88/C3V3			
D31	BS2525	Mullard BZY88/C6V2			
D32	BS2542	STC 1N4148			
D33	BS2542	STC 1N4148			
D34	BS2542	STC 1N4148			
D35	BS2542	STC 1N4148			
D36	BS2542	STC 1N4148			
D37	BS2542	STC 1N4148			
D39	BS2542	STC 1N4148			
D40	BS2542	STC 1N4148			
D41	BS2942	Mullard BZY88/C5V1			
		Resistors (fixed) Ω			
R1	DS7449	Electrosil TR5	470k	2	½ W
R46	DS32512	Electrosil TR5	150k	2	½ W
R47	DS7479	Electrosil TR5	1 k	2	½ W
R48	DS32366	Electrosil TR5	100k	2	½ W
R49	DS7526	Electrosil TR5	10k	2	½ W
R101	DS32357	Electrosil TR5	1.5k	2	½ W
R105	DS33852	Morganite type S	2.2M	10	½ W
R106	DS32439	Electrosil TR5	220k	2	½ W
R108	DS7479	Electrosil TR5	1 k	2	½ W
R109	DS7479	Electrosil TR5	1 k	2	½ W
R110	DS32362	Electrosil TR5	3.3k	2	½ W
R111	DS32234	Electrosil TR5	47	2	½ W
R112	DS32364	Electrosil TR5	220	2	½ W
R113	DS7479	Electrosil TR5	1 k	2	½ W
R114	DS32234	Electrosil TR5	47	2	½ W
R117	DS32357	Electrosil TR5	1.5k	2	½ W
R118	DS32234	Electrosil TR5	47	2	½ W
R123	DS32362	Electrosil TR5	3.3k	2	½ W
R124	DS32362	Electrosil TR5	3.3k	2	½ W

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R125	DS32234	Electrosil TR5	47	2	½ W
R126	DS32316	Electrosil TR5	390	2	½ W
R127	DS32357	Electrosil TR5	1.5k	2	½ W
R129	DS32127	Electrosil TR5	470	2	½ W
R131	DS32356	Electrosil TR5	180	2	½ W
R132	DS7302	Electrosil TR5	10	2	½ W
R133	DS32356	Electrosil TR5	180	2	½ W
R134	DS32128	Electrosil TR5	330	2	½ W
R135	DS32131	Electrosil TR5	2.2k	2	½ W
R136	DS32383	Electrosil TR5	560	2	½ W
R137	DS32234	Electrosil TR5	47	2	½ W
R138	DS7491	Electrosil TR5	1.2k	2	½ W
R139	DS32234	Electrosil TR5	47	2	½ W
R140	DS7479	Electrosil TR5	1 k	2	½ W
R141	DS32358	Electrosil TR5	680	2	½ W
R142	DS32127	Electrosil TR5	470	2	½ W
R143	DS7526	Electrosil TR5	10 k	2	½ W
R145	DS32131	Electrosil TR5	2.2k	2	½ W
R162	DS32357	Electrosil TR5	1.5k	2	½ W
R164	DS32360	Electrosil TR5	47k	2	½ W
R165	DS32360	Electrosil TR5	47k	2	½ W
R166	DS32356	Electrosil TR5	180	2	½ W
R167	DS32359	Electrosil TR5	4.7k	2	½ W
R168	DS32440	Electrosil TR5	15k	2	½ W
R169	DS7302	Electrosil TR5	10	2	½ W
R174	DS32376	Electrosil TR5	27k	2	½ W
R175	DS32440	Electrosil TR5	15k	2	½ W
R176	DS32128	Electrosil TR5	330	2	½ W
R177	DS32359	Electrosil TR5	4.7k	2	½ W
R178	DS32357	Electrosil TR5	1.5k	2	½ W
R179	DS32440	Electrosil TR5	15k	2	½ W
R180	DS32234	Electrosil TR5	47	2	½ W
R181	DS32234	Electrosil TR5	47	2	½ W
R183	DS32316	Electrosil TR5	390	2	½ W

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R184	DS32368	Electrosil TR5	6.8k	2	½ W
R185	DS32385	Electrosil TR5	150	2	½ W
R186	DS32132	Electrosil TR5	2.7k	2	½ W
R187	DS32131	Electrosil TR5	2.2k	2	½ W
R188	DS32357	Electrosil TR5	1.5k	2	½ W
R189	DS32363	Electrosil TR5	22k	2	½ W
R190	DS32385	Electrosil TR5	1.8k	2	½ W
R191	DS32364	Electrosil TR5	220	2	½ W
R192	DS32409	Electrosil TR5	3.9k	2	½ W
R193	DS7526	Electrosil TR5	10k	2	½ W
R194	DS32367	Electrosil TR5	820	2	½ W
R195	DS32131	Electrosil TR5	2.2k	2	½ W
R196	DS32131	Electrosil TR5	2.2k	2	½ W
R197	DS32131	Electrosil TR5	2.2k	2	½ W
R198	DS32131	Electrosil TR5	2.2k	2	½ W
R210	DS32234	Electrosil TR5	47	2	½ W
R211	DS32361	Electrosil TR5	100	2	½ W
R215	DS32234	Electrosil TR5	47	2	½ W
R220	DS32361	Electrosil TR5	100	2	½ W
R222	DS32374	Electrosil TR5	8.2k	2	½ W
R229	DS32358	Electrosil TR5	680	2	½ W
		Resistors (variable) ⏦			
R128	FS10405	Plessey MP/PC Dealer LIN (or Erie 80P-2)	10k	20	¼ W
R144	FS10299	Plessey MP/PC Dealer LIN (or Erie 80P-2)	1 k	20	¼ W
R163	FS10299	Plessey MP/PC Dealer LIN (or Erie 80P-2)	1 k	20	¼ W
R182	FS10353	Plessey MP/PC Dealer LIN (or Erie 80P-2)	220	20	¼ W

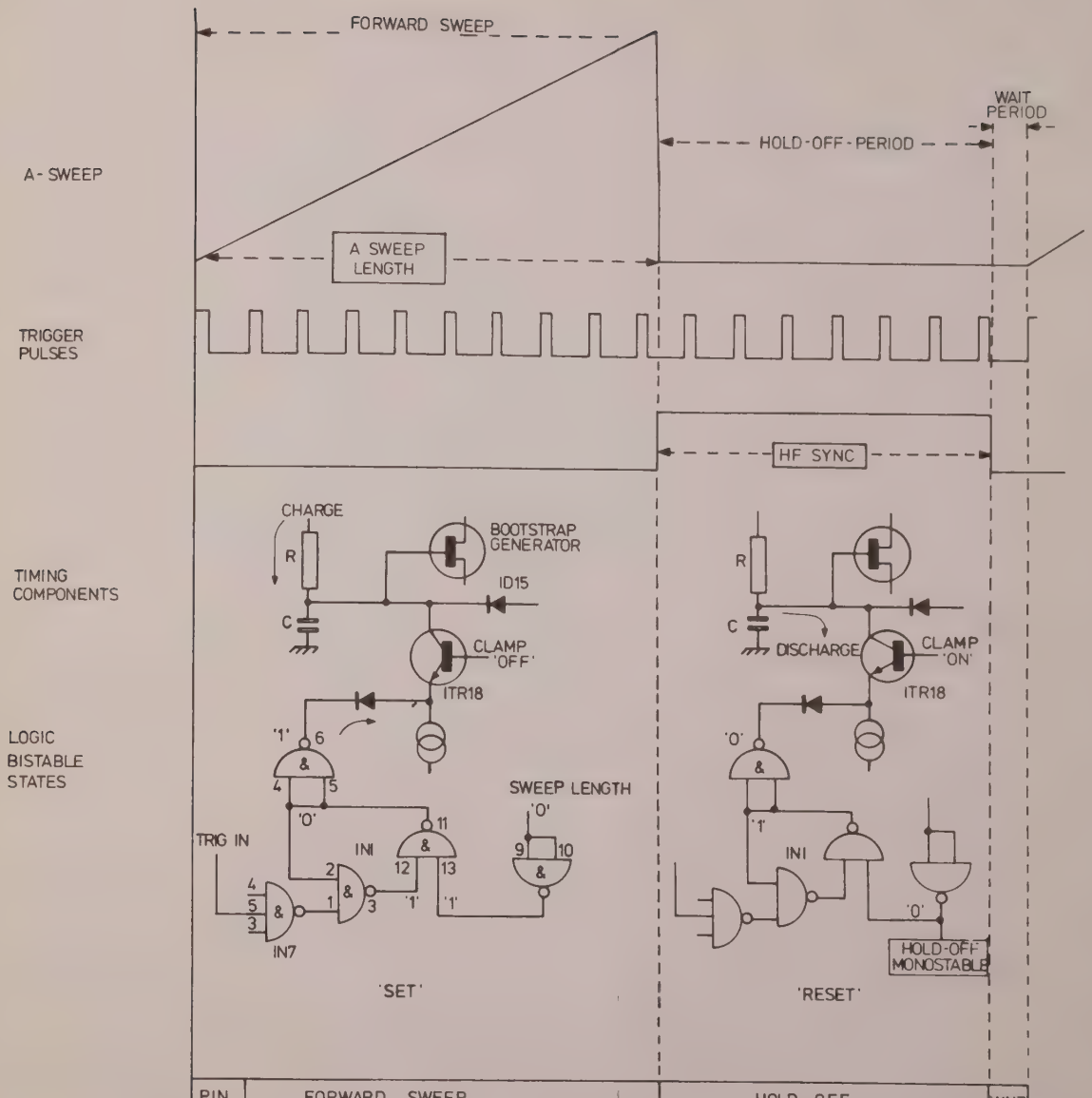
Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Transistors			
TR14		Ferranti ZTX351L (or BSX21)			
TR26	BS2519	Mullard BCY 72			
TR41	BS2938	Texas 2N 5245			
TR42	BS2756	Texas TIS48			
TR47	BS2939	Texas BF357K			
TR48	BS2939	Texas BF357K			
TR49	BS2835	R.C.A. 2N5179			
TR50	BS2835	R.C.A. 2N5179			
TR51	BS2835	R.C.A. 2N5179			
TR52	BS2756	Texas TIS48			
TR53	BS2949	Fairchild 2N5139			
TR54	BS2519	Mullard BCY 72			
TR55	BS2758	Texas 2N5246			
TR56	BS2949	Fairchild 2N5139			
TR57	BS2832	Mullard BC148			
TR58	BS2519	Mullard BCY72			
TR59	BS2756	Texas TIS48			
TR60	BS2756	Texas TIS48			
TR61	BS2756	Texas TIS48			
TR62	BS2949	Fairchild 2N5139			
TR63	BS2949	Fairchild 2N5139			
TR65	BS2832	Mullard BC148			
TR67	BS2756	Texas TIS48			
		Miscellaneous			
N2	BS2550	Integrated Circuit, Texas SN7400N			
N4	BS2550	Integrated Circuit, Texas SN7400N			
N5	BS2550	Integrated Circuit, Texas SN7400N			
N6	BS2727	Integrated Circuit, Texas SN7401N			
T2	C60681/02	Transformer, S.E.L.			



CM1002

A-SWEEP ,TIMEBASE MODULE
SIMPLIFIED BLOCK DIAGRAM

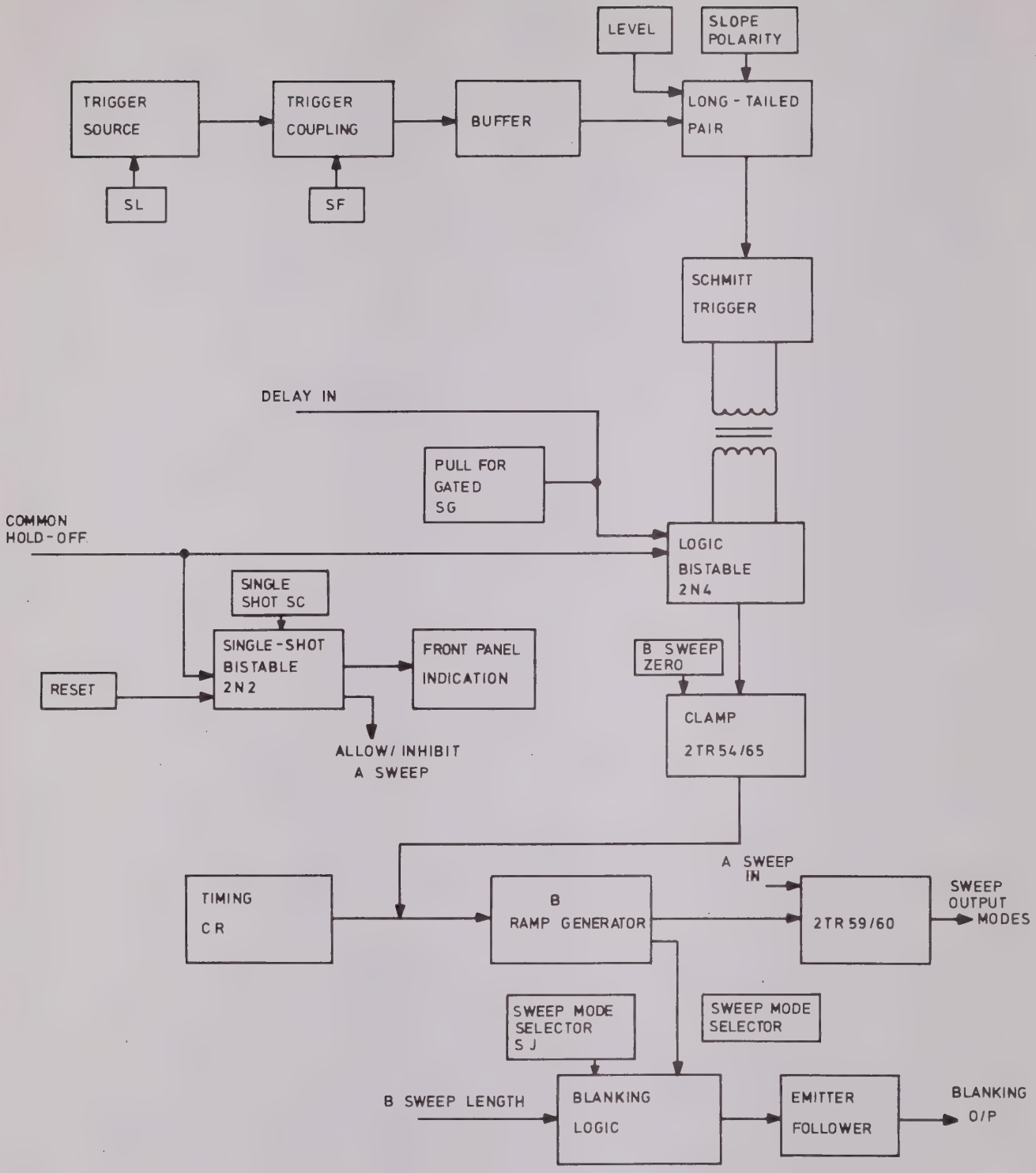
FIG.3.1.



	PIN	FORWARD SWEEP	HOLD-OFF	WAIT
IN7	3, 4	1	1	1
	5	1 or 0	1 or 0	0
IN1	1	0 or 1	0 or 1	1
	2	0	1	1
	3, 12	1	1 or 0	0
	9, 10	0	1 at end of forward sweep	0
	8, 13	1	0	1
	4, 5, 11	0	1	1
	6	1	0	0

CM 1002

A SWEEP WAVEFORM AND LOGIC DIAGRAM FIG3.2



B SWEEP TIMEBASE MODULE

CM1002 SIMPLIFIED BLOCK DIAGRAM FIG. 3.3.

SA	
1	CH1
2	CH2
3	EXT.
4	EXT ÷ 10
5	LINE

SB	
1	AC
2	HF REJECT
3	LF REJECT
4	DC

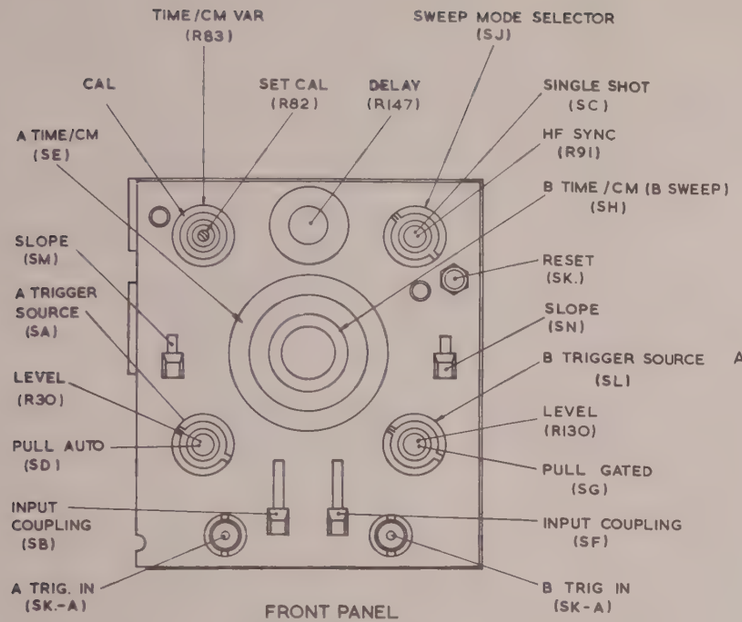
SL	
1	CH1
2	CH2
3	EXT
4	EXT ÷ 10
5	LINE

SF	
1	AC
2	HF REJECT
3	LF REJECT
4	DC

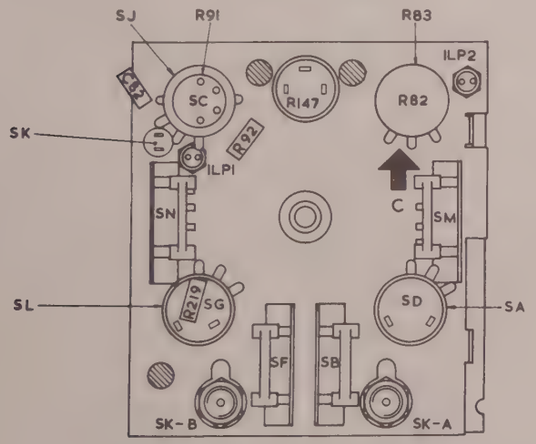
CM1002

FIG. 3.4 X-TIMEBASE MODULE SM602
BLOCK SCHEMATIC

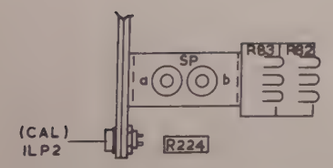
3-28-D



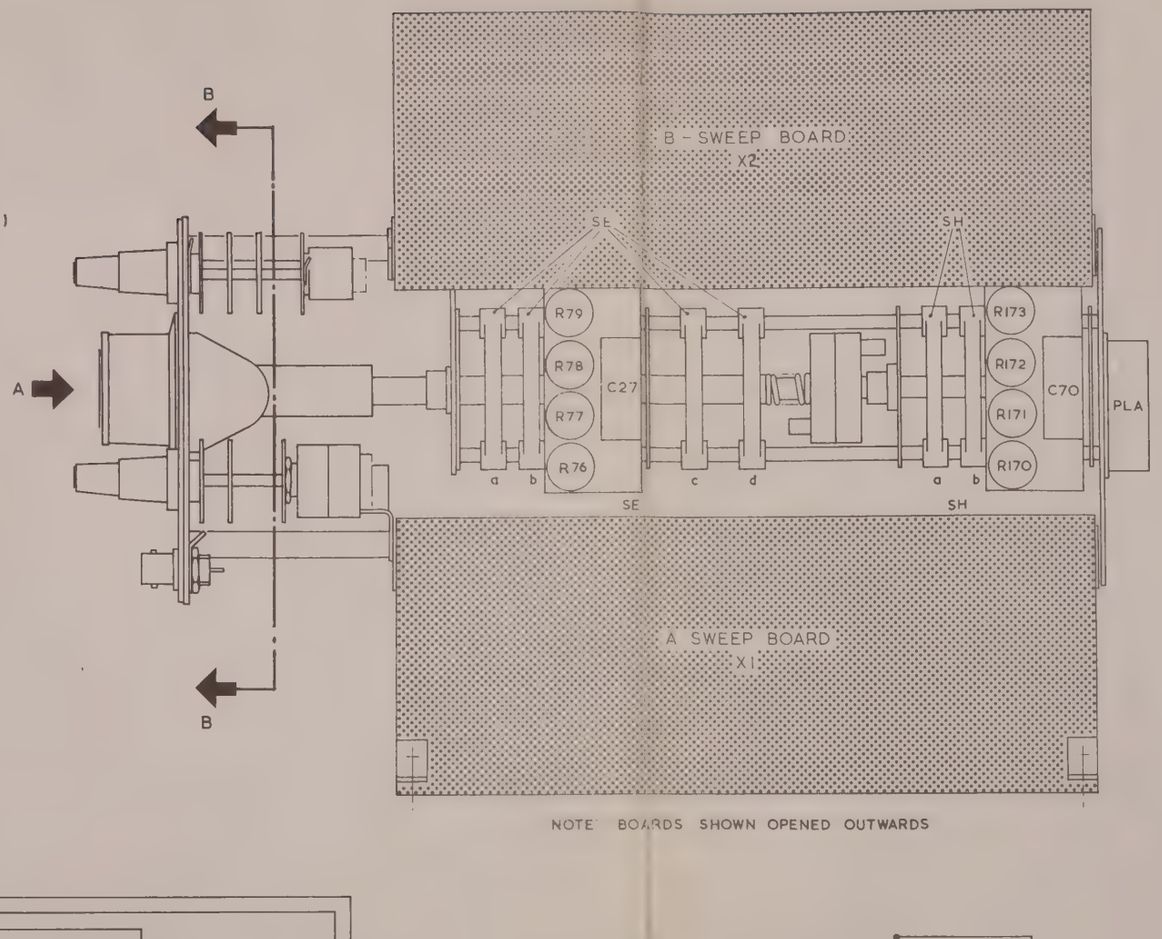
FRONT PANEL
(VIEW ON ARROW A)



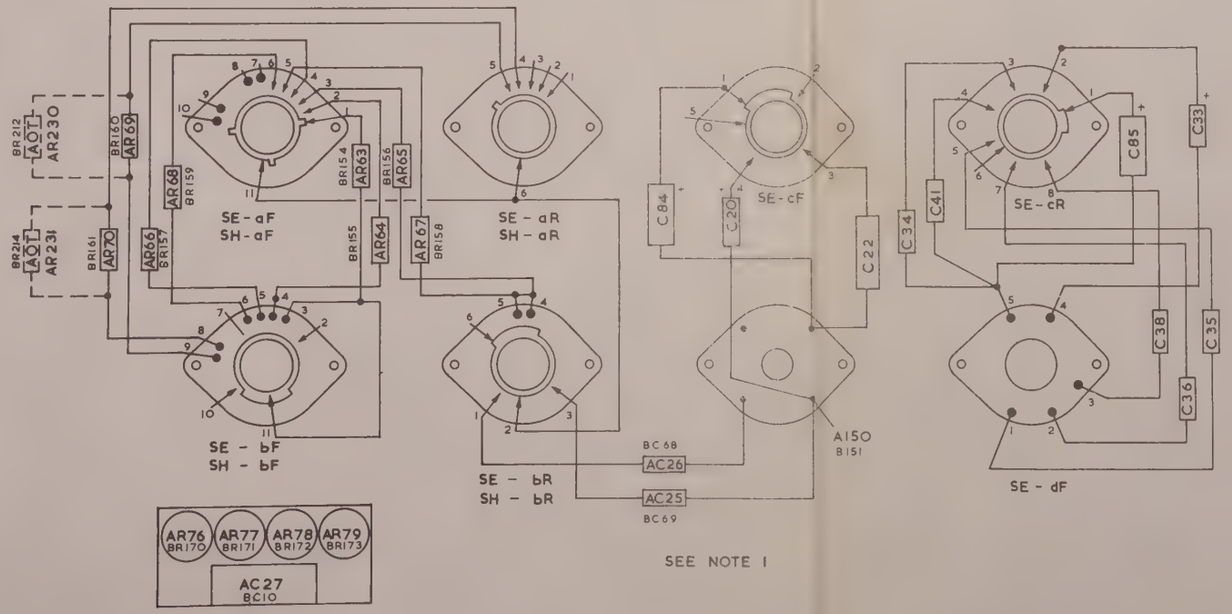
VIEW ON ARROW B



VIEW ON ARROW C



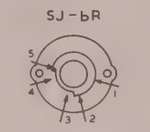
NOTE: BOARDS SHOWN OPENED OUTWARDS

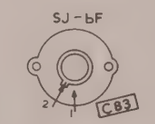


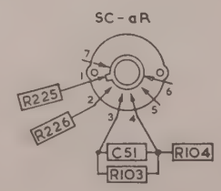
SEE NOTE 1

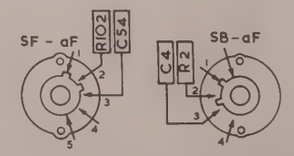
NOTES

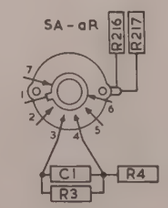
1. ALL COMPONENTS WITH PREFIX A USED WITH SWITCH 'SE' SECTIONS a-b, & SMALL 'A' SWEEP BOARD e.g. AR69. WITH PREFIX 'B' USED WITH SWITCH 'SH' SECTIONS a-b, & SMALL 'B' SWEEP BOARD e.g. BR160
2. DWG. No. E60596/7











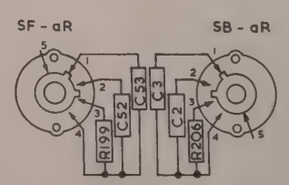


FIG. 3.5. X-TIMEBASE MODULE SM602
COMPONENT LAYOUT SHT. 1.

CM1002

NOTES

1. BROKEN LINES DENOTE CHASSIS MOUNTED ITEMS.
2. PREFIX NUMBERS ON COMPONENT REFERENCES DENOTE PC. BOARD Nos.
3. INTEGRATED CIRCUIT PACKAGES NI TO N6 SHOWN ON SHT. 2.
4. DWG. No. E.60597/14

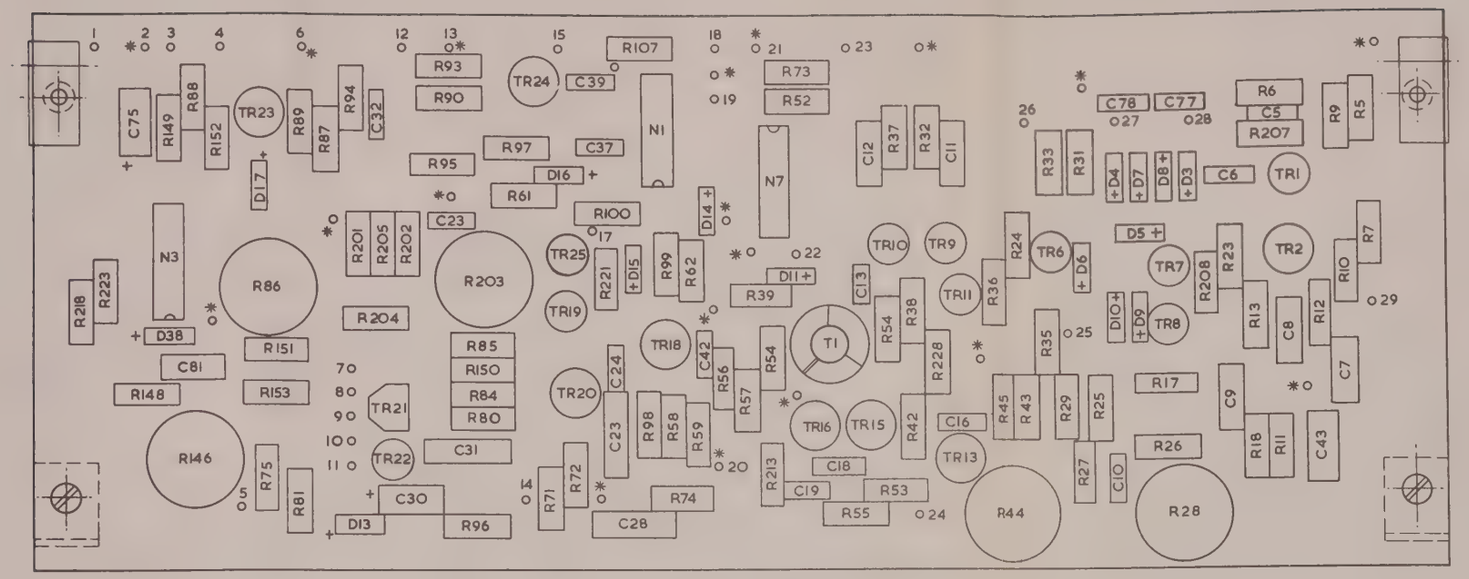
SA	
1	CH. 1
2	CH. 2
3	EXT.
4	EXT. ÷ 10
5	LINE

SB	
1	AC
2	HF REJECT
3	LF REJECT
4	DC

CM 1002

FIG. 3.6. X-TIMEBASE MODULE SM 602
CIRCUIT DIAGRAM (SHT. 1) A SWEEP

3-28-E



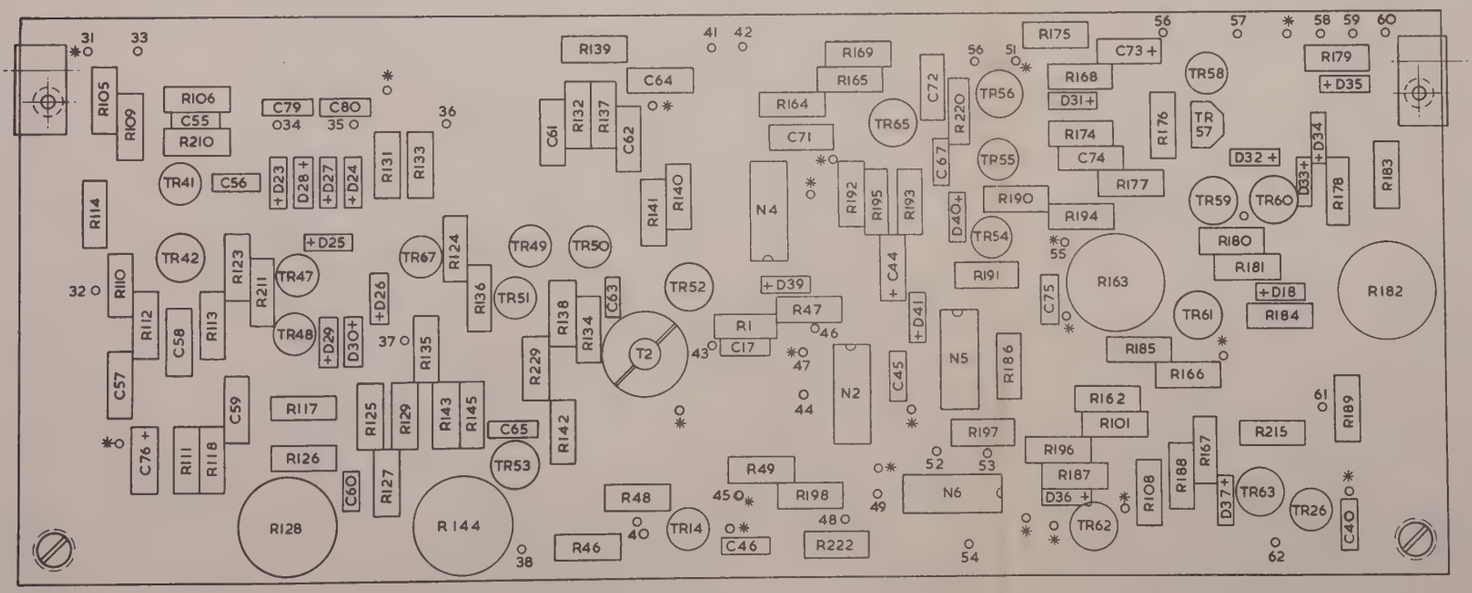


FIG.3.7 X-TIMEBASE MODULE SM602
COMPONENT LAYOUTS (SHT.2)

CM1002

NOTES

1. BROKEN LINES DENOTE CHASSIS MOUNTED ITEMS
2. PREFIX NUMBERS ON COMPONENT REFERENCES DENOTE P.C. BOARD NUMBER.
3. DWG. No. E 60597/14

N1, N2, N4, N5.
SN 7400N
(VIEWED ON TOP)

N3
SN 7271ON
(VIEWED ON TOP)

N6
SN 7401N
(VIEWED ON TOP)

N7
SN 7410N
(VIEWED ON TOP)

SL	
1	CH1
2	CH2
3	EXT
4	EXT ÷ 10
5	LINE

SF	
1	AC
2	HF REJECT
3	LF REJECT
4	DC

FIG. 3.8. X-TIMEBASE MODULE SM602
CIRCUIT DIAGRAM (SHT 2) - B SWEEP

CM1002

3-28-F

4.1 - CIRCUIT DESCRIPTION (FIG. 4.5, 4.6, 4.7, 4.8)

1. INTRODUCTION

The amplifier circuits for channel 1 and channel 2 of the Y-amplifier module are identical. Therefore, the circuit description has been confined to channel 2. However, to show the overall circuit operation, both channels have been included in the simplified block diagram, Fig. 4.1

2. ATTENUATORS (FIG. 4.5, 4.7)

Input coupling, both a.c. and d.c., to the channel 2 amplifier is provided via the 3-pole switch SA. Two series attenuators, switched by the V/cm control SA, feed the amplifier input.

3. PREAMPLIFIER (CHANNEL 2, FIG. 4.6)

Field-effect transistors 1TR1, 1TR2, source coupled to 1TR3 and 1TR4 respectively, form a high-impedance input buffer stage balanced by the preset front-panel control R20.

This buffer stage is coupled to phase splitter 1TR5, 1TR6, 1TR7 and 1TR8. The pull switch SC and preset R86 in the emitter circuit are the front-panel controls for increasing the overall gain of the stage by a factor of 10. An additional balance preset is provided in the base circuit of 1TR7, 1TR8. This balances the collectors of 1TR7 and 1TR8 so that there is zero shift when the FINE GAIN control R54 is operated.

The next stage of the preamplifier comprises transistors 1TR9 to 1TR12. The emitter circuit of 1TR9 and 1TR10 contains the front-panel fine gain and SET(cal) controls. Preset capacitor 1C43 and resistor 1R32 in the collector circuit set the pulse response at h.f. for the Y waveform. The Y SHIFT control applies -12 V differentially to the base circuits of 1TR11, 1TR12.

The output stage of the preamplifier comprises 1TR13 and 1TR14, which are diode coupled to the PULL TO INVERT switch SE. This switch provides for the inversion of channel 2 signals. Choice of channel 1 and for channel 2 is achieved by the diode switching.

4. OUTPUT AMPLIFIER

Transistors 1TR38, 1TR39 provide the final output stage of the Y amplifier module for the combined deflection signal, the outputs to the main frame delay line being routed to PLA pins 5 and 13.

5. TRIGGER AMPLIFIER

The trigger amplifier for channel 2 comprises transistors 1TR15 to 1TR19. The trigger zero preset 1R73 controls the collector voltage of 1TR19. Transistors 1TR18,

1TR19 form the trigger output stage.

6. VERTICAL MODE SELECTION

Vertical mode selection is achieved by means of switch SD. It controls the operation of the bistable 2TR26, 2TR28. The bistable is switched from the alternate trigger input pulses via the logic gate 2N1, to give dual display in the ALT position. The output of 2TR26 and 2TR28 drives the diode switch, D3 to D6 and D22 to D25. In the CH1 position 2TR28 is switched on and 2TR26 is switched off, and vice versa for CH2. Thus, the diode switch allows one channel at a time. For the ADD mode, both 2TR26 and 2TR28 are switched on by the diodes so that both channels are operative.

4.2 - ALIGNMENT PROCEDURES

1. TEST EQUIPMENT

   (a) Fast Squarewave Generator (Tekronix 106 or similar) with lead, 50 Ω termination and 10 : 1 pad.

   (b) Oscilloscope Calibrator (Bradley 156 or similar).

   (c) Serviceable SM112 Main Frame.

   (d) Serviceable Timebase Module SM602.

   (e) T-Connector, BNC type and short BNC lead.

   (f) Input Capacitance Standardiser (adjusted to 23 pF).

2. PRELIMINARY SETTING-UP (INITIAL BALANCE)

   NOTE: Where checks are identical for channels 1 and 2, channel 2 component references (or control annotations, etc.) are quoted in brackets, immediately following the channel 1 component reference.

   (a) Connect the unit-under-test (SM599) to a serviceable X-amplifier Module SM602, and plug both units into a serviceable SM112 Main Frame. Switch-on and allow a warm-up period of at least 5 minutes to elapse.

   (b) Set all internal and front panel potentiometers to mid-position.

   (c) Switch both channels (CH1, CH2) to the 0.01 V/cm range x 1 gain, alternate sweep (ALT), input selector (AC GND DC) to GND (ground).

   (d) Adjust CH1 and CH2 BAL preset controls to position each trace in centre of the graticule.

3. CHANNEL 1 (CHANNEL 2) FINE GAIN BALANCE

   (a) Rotate the CH1 (CH2) V/cm fine gain control. If the trace moves, adjust the fine gain balance control 1R207 (1R37) so that it moves by less than 2 mm, when the V/cm fine gain control is rotated throughout its travel. If required, adjust CH1 (CH2) BAL preset control to keep the trace on the screen during the adjustment.

4. CHANNEL 1 (CHANNEL 2) x 1/ x 10 BALANCE

   (a) Adjust the CH1 (CH2) BAL control so that the trace moves by less than 5 mm, when switching between x 1 and x 10 gain settings of the CH1 (CH2) PULL x 10 control.

   (b) Adjust CH1 (CH2) SHIFT control to keep the trace on the screen, if necessary.

5. CHANNEL 1 (CHANNEL 2) LEAKAGE

(a) Set CH1 (CH2) x 10 gain to PULL x 10 and CH1 (CH2) AC GND DC input selector to DC.

(b) Switch the CH1 (CH2) input selector between DC and GND positions and adjust CH1 (CH2) offset potentiometer 1R185 (1R17) so that the trace moves by less than 2 mm.

6. CHANNEL 1 (CHANNEL 2) TRIGGER ZERO

(a) Set the CH1 (CH2) PULL x 10 gain control to x 1 and the CH1 (CH2) trace to the centre of the screen.

(b) Adjust the CH1 (CH2) trigger zero potentiometer 1R243(1R73) for a voltage of zero ± 50 mV at pin 48 (pin 43) of board 1.

7. CHANNEL 1 (CHANNEL 2) CALIBRATOR

(a) Set CH1 (CH2) PULL x 10 to x 1, CH1 (CH2) AC GN DC Input Selector to DC.

(b) Apply a squarewave input of 60 mV at 1 kHz, using the Test Oscilloscope Calibrator (Bradley) connected to CH1 IN (CH2 IN) input socket.

(c) Set the CH1 (CH2) V/cm Fine control to CAL and check that the CH1 (CH2) CAL indicator lights up.

(d) Adjust CH1 (CH2) SET (Cal) preset control to obtain a deflection of 6 cm on the c.r.t.

(e) Reduce the input to 6 mV. Set the CH1 (CH2) x 10 gain to PULL x 10 position. Adjust the CH1 (CH2) x 10 gain potentiometer 1R105 (1R86) to obtain a deflection of 6 cm on the c.r.t.

8. INVERT BALANCE

(a) Set CH2 PULL x 10 x 1 gain and with no input applied position the channel 2 trace at the centre of the c.r.t. Pull out the PULL TO INVERT switch.

(b) Re-position the trace using the CH2 SHIFT control so that the Y displacement, when the PULL TO INVERT switch is pulled, is less than 2 mm.

(c) Check that the trace is within ± 2 cm of the Y centre-line at this point.

9. VERTICAL MODE

(a) Set both channels to x 1 gain, invert channel 2 (PULL TO INVERT). Apply a squarewave input of 80 mV at 1 kHz to both CH1 and CH2 inputs, using the BNC T-connector. Two 8 cm squarewave in anti-phase should now be displayed. Adjust CH1 and CH2 SHIFT controls, so that the waveforms interleave, giving two straight lines at the extremes of the graticule.

(b) Set the Vertical Mode Switch to CH1 + CH2. A straight line, within ± 2 cm of the graticule centre should be displayed. The residual squarewave should be less than 1 mm.

(c) Check that the CH1, CH2 and CHOP positions of the Vertical Mode Switch operate as indicated.

10. CHANNEL 1 (CHANNEL 2) INPUT CAPACITY

(a) Connect the input squarewave (set to 80 mV at 1 kHz) via the Input Capacitance Standardiser to CH1 IN (CH2 IN).

(b) Set:

(i) PULL x 10 x 1 gain.

(ii) AC GND DC to DC.

(iii) V/CM switch to 0.01 V/cm.

(c) Adjust 1C54 (1C17) to give no overshoot or undershoot on the displayed waveform.

11. CHANNEL 1 (CHANNEL 2) ATTENUATOR SETTINGS

(a) Connect the input squarewave (set at 1 kHz) directly to CH1 IN (CH2 IN).

(b) Set the input squarewave level to the amplitudes listed below and set the appropriate variable capacitor against the V/cm range selected, to obtain the display amplitude listed.

Input Signal	V/cm Setting CH1 (CH2)	Adjust CH1 (CH2)	Display Amplitude (± 1 mm)
20 mV	0.02	C10	6 cm
50 mV	0.05	C13	6 cm
0.1 V	0.1	C2	6 cm
0.2 V	0.2	C12	6 cm
0.5 V	0.5	C15	6 cm
1 V	1	C4	6 cm
2 V	2	Check	6 cm
5 V	5	Check	6 cm
10 V	10	C6	6 cm
20 V	20	Check	6 cm
20 V	50	Check	4 cm

12. CHANNEL 1 (CHANNEL 2) ATTENUATOR INPUT CAPACITY

(a) Connect the input squarewave (at 1 kHz) set to the amplitudes listed below and adjust the appropriate variable capacitor against the V/cm setting selected, to obtain the display amplitudes listed.

NOTE: Insert the Capacitance Standardiser between the channel 1 (channel 2) input and the Squarewave Generator.

Input Signal	V/cm Setting CH1 (CH2)	Adjust CH1 (CH2)	Display Amplitude ± 1 mm
10 mV	0.01	Check	5 cm
20 mV	0.02	Check	5 cm
50 mV	0.05	Check	5 cm
0.1 V	0.1	C3	5 cm
1 V	1	C5	5 cm
10 V	10	C7	5 cm

13. CHANNEL 1 (CHANNEL 2) PROBE SUPPLIES

(a) Check for ± 12 V probe supplies on the CH1 (CH2) PROBE POWER sockets as listed below.

Pin No.	Supply
A	+12 V
B	-12 V
C	0 V

1. INTRODUCTION

This section contains information on the maintenance of the Y-amplifier module SM599. Routine maintenance and cleaning should be carried out preferably before the alignment procedures already detailed. After replacement of components, recalibration of the associated circuits must be carried out in accordance with the procedures outlined.

2. ACCESSIBILITY (FIG. 4.3, 4.4)

Two press-and-turn sockets located on the right-hand-side panel provide for integral mounting with a SM602 unit.

Card 1 and the preset controls are located on the underside of the unit.

Access to Card 2 and the Channel 1 controls can be gained by removing the screening plate on the left-hand-side of the unit. This is removed by unscrewing the two screws on the side of the plate, the screw on the bracket and slackening the two screws at the rear of the unit.

Access to the Channel 2 controls can be gained by removing the dividing screen on the right-hand-side of the unit, held in position by five screws.

After maintenance, ensure that all retaining screws are secured.

3. PREVENTIVE MAINTENANCE

A preventive maintenance routine includes, cleaning, visual inspection and lubrication and if performed periodically, can prevent breakdown. The frequency of maintenance is determined by the environment to which the unit is subjected: the ideal time for a routine maintenance check is immediately preceding recalibration.

3.1 CLEANING

Due to its heat-insulating effect on components, dust accumulation within the unit reduces heat dissipation and can cause breakdown.

A dry low-velocity air line is recommended for removing dust, a small brush being particularly useful for dislodging dirt in inaccessible places such as switch wafers and on or under front-panel controls.

3.2 VISUAL INSPECTION

Periodically inspect the unit for mechanical defects (e.g. on rotary switches or support brackets), for broken connections, including the printed wiring on the circuit cards, and for evidence of overheated components.

The occasional use of an approved lubricant (one that does not affect electrical or mechanical characteristics) can help to maintain the reliability of moving parts (e.g. rotary switches and potentiometers). Do not over-lubricate. Panclimatic grease should be used to lubricate concentric shafts.

4. REMOVAL OF FRONT-PANEL CONTROL KNOBS

The rotary control knobs can be removed by first prising off the centre cap and then unscrewing the retaining screw or hexagonal nut.

The knobs for the slider switches are of the pull-off type.

1. INTRODUCTION

This section contains information for ordering replaceable parts. The tables provide the following information:

(a) Circuit Reference.

(b) Value, Tolerance and rating (where applicable).

(c) Manufacturer/Reference.

(d) SEL Part No.

Minor items, such as screws, nuts, etc., have not been included as they are not considered special to the equipment.

2. ORDERING INFORMATION

To order your replacement parts, address the order to your local agent or to S.E. LABORATORIES (ENGINEERING) LTD. SERVICE DEPARTMENT, NORTH FELTHAM TRADING ESTATE, FELTHAM, MIDDLESEX, ENGLAND.
Telephone No. 01-890-1166/5876.

Specify the following information for each part:

(a) Model and serial number of the equipment.

(b) SEL part number, and manufacturer's reference.

(c) Circuit reference.

(d) Description (i.e. Value, Tolerance and rating).

To order a part not listed, give the part number, description of the major assembly which is listed, and a complete description of the part required.

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Sub-Assemblies			
	B60662	Channel 1 Attenuator			
	B60662	Channel 2 Attenuator			
	60614	Y-Amplifier Card 1			
	60624	Y-Amplifier Card 2			
		Capacitors (fixed) μF			
C51	CS30362	Erie 801/K800011	0.01	+80 -20	500 V
C68	CS30999	Erie 831/N220	22p	20	
C69	CS30999	Erie 831/N220	22p	20	
C74	CS30362	Erie 801/K800011	0.01	+80 -20	500 V
C81	CS30352	Mullard C281AB/A100K	0.1	10	250 V
C82	CS30352	Mullard C281AB/A100K	0.1	10	250 V
		Resistors (fixed) Ω			
R1	DS33722	Mullard MR25	47	2	
R19	DS32362	Electrosil TR5	3.3k	2	½ W
R21	DS32362	Electrosil TR5	3.3k	2	½ W
R31	DS32402	Electrosil TR5	27	2	½ W
R48	DS32697	Electrosil TR5	150k	2	½ W
R51	DS32234	Electrosil TR5	47	2	½ W
R52	DS32234	Electrosil TR5	47	2	½ W
R57	DS32357	Electrosil TR5	1.5k	2	½ W
R59	DS32357	Electrosil TR5	1.5k	2	½ W
R81	DS7479	Electrosil TR5	1 k	2	½ W
R101	DS7479	Electrosil TR5	1 k	2	½ W
R189	DS32362	Electrosil TR5	3.3k	2	½ W
R191	DS32362	Electrosil TR5	3.3k	2	½ W
R202	DS32402	Electrosil TR5	27	2	½ W
R221	DS32234	Electrosil TR5	47	2	½ W
R222	DS32234	Electrosil TR5	47	2	½ W
R228	DS32357	Electrosil TR5	1.5k	2	½ W
R230	DS32357	Electrosil TR5	1.5k	2	½ W

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R263	DS32697	Electrosil TR5	150k	2	½ W
R264	DS32697	Electrosil TR5	150k	2	½ W
R265	DS33722	Mullard MR25	47	2	
R276	DS7479	Electrosil TR5	1 k	2	½ W
		Miscellaneous			
ILP1		Neon, Osmor, 250/1/Red			
ILP2		Neon, Osmor, 250/1/Red			
ILP3		Neon, Osmor, 250/1/Red			
R229	DS33846	Resistor, Variable AB Electronic Components, type 45	470	20	
SE	QS22310	Switch, slider, AB Electronic Components, VP type A			
SD	D60566	Switch (Y Mode)			
SG + R58	DS33870	Switch and Resistor Variable, AB Electronic Components, K-45	470	20	
PLA	AS0585	Plug, McMurdo RP16			
SKTA	AS1469	Socket BNC, GE35026	50Ω		
SKTB	AS1469	Socket BNC, GE35026	50Ω		
SKTC	AS1512	Socket, Ether, SM35-XA-N			
SKTD	AS1512	Socket, Ether, SM35-XA-N			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Capacitors (fixed) µF			
C1	CS30989	Waycom, Wima MKS	0.033	20	630 V
C8	CS30993	Erie, NPO/8123-000	100 p	20	100 V
C9	CS4870	Suflex, HS1000/S-7/30	1000p	5	30 V
C11	CS31006	Erie 861/N150	8.2 p	±0.5 p	500 V
C22	CS31006	Erie 861/N150	8.2 p	±0.5 p	500 V
C23	CS31006	Erie 861/N150	8.2 p	±0.5 p	500 V
C24	CS31006	Erie 861/N150	8.2 p	±0.5 p	500 V
C61	CS31008	Erie 861/NPO	2.2 p	±0.5 p	500 V
C75	CS31007	Erie 861/N150	10 p	5	500 V
C76	CS31004	Erie 861/NPO	4.7 p	±0.5 p	500 V
C85	CS31007	Erie 861/N150	10 p	± 5%	500 V
		Capacitors (variable)			
C2	CS30987	Steatite, R-Triko 112-06	1p-4p		
C3	CS30192	Mullard C004EA/6E	0.8p-7p		
C4	CS30987	Steatite, R-Triko 112-06	1p-4p		
C5	CS30192	Mullard C004EA/6E	0.8p-7p		
C6	CS30988	Steatite, R-Triko 109-05	0.5p-3p		
C7	CS30192	Mullard C004EA/6E	0.8p-7p		
C10	CS30987	Steatite, R-Triko 112-06	1p-4p		
C12	CS30192	Mullard C004EA/6E	0.8p-7p		
C13	CS30987	Steatite, R-Triko 112-06	1p-4p		
C15	CS30192	Mullard C004EA/6E	0.8p-7p		
		Resistors (fixed) Ω			
R2	DS33971	Erg RE-0.5-900K-F-CO	900 k	1	
R3	DS33973	Erg RE-0.5-990K-F-CO	990 k	1	
R4	DS33874	Mullard MR30	1 M	1	
R5	DS33972	Erg RE-0.5-111K-F-CO	111 k	1	
R6	DS33970	Erg RE-0.5-10.1K-F-CO	10.1 k	1	
R7	DS33876	Mullard MR25	1 k	1	$\frac{1}{4}$ W
R8	DS33706	Mullard MR25	10	2	

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R9	DS33966	Mullard MR30	499k	1	$\frac{1}{4}$ W
R10	DS33874	Mullard MR30	1 M	1	
R11	DS33267	Morganite FC65	800k	1	$\frac{1}{4}$ W
R12	DS33967	Mullard MR30	249k	1	$\frac{1}{4}$ W
R153	DS33734	Mullard MR25	150	2	
R154	DS33756	Mullard MR25	1.2k	2	
R155	DS33718	Mullard MR25	33	2	
R156	DS33758	Mullard MR25	1.5k	2	
R157	DS33756	Mullard MR25	1.2k	2	
R158	DS33892	Mullard CR16	150	10	0.2W
R159	DS33740	Mullard MR25	270	2	
		Resistors (variable) ∽			
R20	DS33844	AB Electronic Components, type 44	470	20	
R54 + SC	DS33924	AB Electronic Components, type K-45 Inv.LOG	470	20	
R55	DS33869	AB Electronic Components, type 44 LIN	100	20	
R190	DS33844	AB Electronic Components, type 44	470	20	
R224 + SJ	DS33924	AB Electronic Components, type K-45 Inv. LOG	470	20	
R225	DS33869	AB Electronic Components, type 44 LIN	100	20	
		Miscellaneous			
SA	D60677	Switch, Lever, SEL			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Capacitors (fixed) µF			
C14	CS30995	Erie 831/K120051, type 2	470p	20	500V
C16	CS30168	Erie 831/K350081	1500p	20	500V
C18	CS30958	Erie 831/K350081	1000p	20	500V
C19		Mullard 015-17688	6.8	+50-10	40 V
C20	CS30954	Erie 801/K800011	0.01	+80-20	250V
C21	CS30951	Mullard C280AE/P100K/040	0.1	20	500V
C25	CS30958	Erie 831/K350081	1000p	20	500V
C26	CS30958	Erie 831/K350081	1000p	20	500V
C27	CS30954	Erie 801/K800011	0.01	+80-20	250V
C28	CS30954	Erie 801/K800011	0.01	+80-20	250V
C34	CS30951	Mullard C280AE/P100K/040	0.1	20	500V
C35		Mullard 015-16109	10	+50-10	25V
C40	CS30951	Mullard C280AE/P100K/040	0.1	20	500V
C42	CS30951	Mullard C280AE/P100K/040	0.1	20	500V
C44	CS30995	Erie 831/K120051, type 2	470p	20	500V
C45	CS30954	Erie 801/K800011	0.01	+80-20	250V
C46	CS30954	Erie 801/K800011	0.01	+80-20	250V
C47	CS30954	Erie 801/K800011	0.01	+80-20	250V
C52	CS30958	Erie 831/K350081	1000p	20	500V
C53	CS30958	Erie 831/K350081	1000p	20	500V
C55	CS30168	Erie 831/K350081	1500p	20	500V
C56	CS30958	Erie 831/K350081	1000p	20	500V
C57		Mullard 015-17688	6.8	+50-10	40V
C58	CS30954	Erie 801/K800011	0.01	+80-20	250V
C59	CS30951	Mullard C280AE/P100K/040	0.1	20	500V
C60	CS31061	Erie 831/NPO	10	20	500V
C62	CS30951	Mullard C280AE/P100K/040	0.1	20	500V
C64		Mullard 015-16109	10	+50-10	25 V
C66	CS31061	Erie 831/NPO	10	20	500V
C67	CS30951	Mullard C280AE/P100K/040	0.1	20	500V
C70	CS30954	Erie 801/K800011	0.01	+80-20	250V
C71	CS30954	Erie 801/K800011	0.01	+80-20	250V
C73	CS30951	Mullard C280AE/P100K/040	0.1	20	500V

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
C79	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
C80	CS39054	Erie 801/K800011	0.01	+80 -20	250 V
C83	CS30991	I.T.T. Tantalum TAG 10/16	10	+50 -20	16 V
C84	CS30991	I.T.T. Tantalum TAG 10/16	10	+50 -20	16 V
C87	CS31000	Erie 831/N220	22 p	20	500 V
C88	CS30956	Erie 831/NPO	15 p	20	500 V
C90	CS30998	Erie 831/N4200	220 p	20	500 V
C91	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
C92	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
C94	CS30998	Erie 831/N4200	220 p	20	500 V
C96	CS31061	Erie 831/NPO	10	20	500 V
C97	CS31061	Erie 831/NPO	10	20	500 V
		Capacitors (variable)			
C17	CS30805	Mullard C004EA/3E	0.5p-3p		
C43	CS30985	Steatite 5S Triko-03, N1500	6p-22p		
C54	CS30805	Mullard C004EA/3E	0.5p-3p		
C63	CS30985	Steatite 5S Triko-03, N1500	6p-22p		
C89	CS30986	Steatite 5S Triko-03, N033	2p-6p		
C93	CS30986	Steatite 5S Triko-03, N033	2p-6p		
		Diodes			
D2	BS2754	Ferranti ZS 150			
D3	BS2542	STC 1N4148			
D4	BS2542	STC 1N4148			
D5	BS2542	STC 1N4148			
D6	BS2542	STC 1N4148			
D7	BS2687	Texas 1S 2100A			
D8	BS2687	Texas 1S 2100A			
D9	BS2543	Zener	4.7 V		
D10	BS2785	Zener	13 V		
D11	BS2785	Zener	13 V		
D12	BS2543	Zener	4.7 V		
D21	BS2754	Ferranti ZS 150			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
D22	BS2542	STC 1N4148			
D23	BS2542	STC 1N4148			
D24	BS2542	STC 1N4148			
D25	BS2542	STC 1N4148			
D26	BS2687	Texas 1S 2100A			
D27	BS2687	Texas 1S 2100A			
D28	BS2543	Zener	4.7V		
		Resistors (fixed) Ω			
R13	DS7449	Electrosil TR5	470k	2	
R14	DS33874	Mullard MR30	1 M	1	
R15	DS33806	Mullard MR25	150k	2	
R16	DS33730	Mullard MR25	100	2	
R18	DS33752	Mullard MR25	820	2	
R22	DS33746	Mullard MR25	470	2	
R23	DS33746	Mullard MR25	470	2	
R24	DS33754	Mullard MR25	1 k	2	
R25	DS33756	Mullard MR25	1.2k	2	
R26	DS33756	Mullard MR25	1.2k	2	
R27	DS33706	Mullard MR25	10	2	
R28	DS33750	Mullard MR25	680	2	
R30	DS33722	Mullard MR25	47	2	
R33	DS33722	Mullard MR25	47	2	
R34	DS33706	Mullard MR25	10	2	
R35	DS33750	Mullard MR25	680	2	
R36	DS33754	Mullard MR25	1 k	2	
R38	DS33754	Mullard MR25	1 k	2	
R39	DS33750	Mullard MR25	680	2	
R40	DS33744	Mullard MR25	390	2	
R41	DS33752	Mullard MR25	820	2	
R42	DS33744	Mullard MR25	390	2	
R43	DS33706	Mullard MR25	10	2	
R44	DS33706	Mullard MR25	10	2	

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R45	DS33762	Mullard MR25	2.2k	2	
R46	DS33762	Mullard MR25	2.2k	2	
R47	DS33742	Mullard MR25	330	2	
R49	DS33742	Mullard MR25	330	2	
R50	DS33722	Mullard MR25	47	2	
R53	DS33722	Mullard MR25	47	2	
R56	DS33746	Mullard MR25	470	2	
R60	DS33746	Mullard MR25	470	2	
R61	DS33746	Mullard MR25	470	2	
R62	DS33742	Mullard MR25	330	2	
R63	DS33728	Mullard MR25	82	2	
R64	DS33758	Mullard MR25	1.5k	2	
R65	DS33758	Mullard MR25	1.5k	2	
R66	DS33728	Mullard MR25	82	2	
R67	DS33742	Mullard MR25	330	2	
R68	DS33742	Mullard MR25	330	2	
R69	DS33730	Mullard MR25	100	2	
R70	DS33752	Mullard MR25	820	2	
R71	DS33744	Mullard MR25	390	2	
R72	DS33756	Mullard MR25	1.2k	2	
R74	DS33754	Mullard MR25	1 k	2	
R75	DS33758	Mullard MR25	1.5k	2	
R76	DS33758	Mullard MR25	1.5k	2	
R78	DS33754	Mullard MR25	1 k	2	
R79	DS33742	Mullard MR25	330	2	
R80	DS33728	Mullard MR25	82	2	
R82	DS33750	Mullard MR25	680	2	
R83	DS33746	Mullard MR25	470	2	
R84	DS33766	Mullard MR25	3.3k	2	
R87	DS33722	Mullard MR25	47	2	
R88	DS33722	Mullard MR25	47	2	
R89	DS33762	Mullard MR25	2.2k	2	
R90	DS33738	Mullard MR25	220	2	
R91	DS33706	Mullard MR25	10	2	

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R92	DS33770	Mullard MR25	4.7k	2	
R93	DS33718	Mullard MR25	33	2	
R94	DS33706	Mullard MR25	10	2	
R100	DS33728	Mullard MR25	82	2	
R101	DS33722	Mullard MR25	47	2	
R102	DS33722	Mullard MR25	47	2	
R103	DS33738	Mullard MR25	220	2	
R104	DS33722	Mullard MR25	47	2	
R106	DS33742	Mullard MR25	330	2	
R109	DS33706	Mullard MR25	10	2	
R140	DS33760	Mullard MR25	1.8k	2	
R142	DS33760	Mullard MR25	1.8k	2	
R143	DS33752	Mullard MR25	820	2	
R145	DS33752	Mullard MR25	820	2	
R149	DS33740	Mullard MR25	270	2	
R150	DS33740	Mullard MR25	270	2	
R151	DS33728	Mullard MR25	82	2	
R152	DS33762	Mullard MR25	2.2k	2	
R161	DS33746	Mullard MR25	470	2	
R162	DS33746	Mullard MR25	470	2	
R165	DS33722	Mullard MR25	47	2	
R166	DS33722	Mullard MR25	47	2	
R181	DS33728	Mullard MR25	82	2	
R182	DS33806	Mullard MR25	150k	2	
R183	DS33874	Mullard MR30	1 M	1	
R184	DS33730	Mullard MR25	100	2	
R186	DS7449	Electrosil TR5	470k	2	
R187	DS33746	Mullard MR25	470	2	
R188	DS33754	Mullard MR25	1 k	2	
R192	DS33746	Mullard MR25	470	2	
R193	DS33762	Mullard MR25	2.2k	2	
R194	DS33746	Mullard MR25	470	2	
R195	DS33706	Mullard MR25	10	2	
R196	DS33706	Mullard MR25	10	2	

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R197	DS33756	Mullard MR25	1.2k	2	
R198	DS33756	Mullard MR25	1.2k	2	
R200	DS33750	Mullard MR25	680	2	
R203	DS33706	Mullard MR25	10	2	
R204	DS33722	Mullard MR25	47	2	
R205	DS33722	Mullard MR25	47	2	
R206	DS33754	Mullard MR25	1 k	2	
R208	DS33754	Mullard MR25	1 k	2	
R209	DS33750	Mullard MR25	680	2	
R210	DS33750	Mullard MR25	680	2	
R211	DS33752	Mullard MR25	820	2	
R212	DS33744	Mullard MR25	390	2	
R213	DS33744	Mullard MR25	390	2	
R214	DS33706	Mullard MR25	10	2	
R215	DS33706	Mullard MR25	10	2	
R216	DS33762	Mullard MR25	2.2k	2	
R217	DS33762	Mullard MR25	2.2k	2	
R218	DS33722	Mullard MR25	47	2	
R219	DS33742	Mullard MR25	330	2	
R220	DS33722	Mullard MR25	47	2	
R223	DS33722	Mullard MR25	47	2	
R226	DS33746	Mullard MR25	470	2	
R227	DS33746	Mullard MR25	470	2	
R231	DS33746	Mullard MR25	470	2	
R232	DS33742	Mullard MR25	330	2	
R233	DS33728	Mullard MR25	82	2	
R234	DS33758	Mullard MR25	1.5k	2	
R235	DS33758	Mullard MR25	1.5k	2	
R236	DS33728	Mullard MR25	82	2	
R237	DS33742	Mullard MR25	330	2	
R238	DS33742	Mullard MR25	330	2	
R239	DS33730	Mullard MR25	100	2	
R240	DS33752	Mullard MR25	820	2	
R241	DS33744	Mullard MR25	390	2	

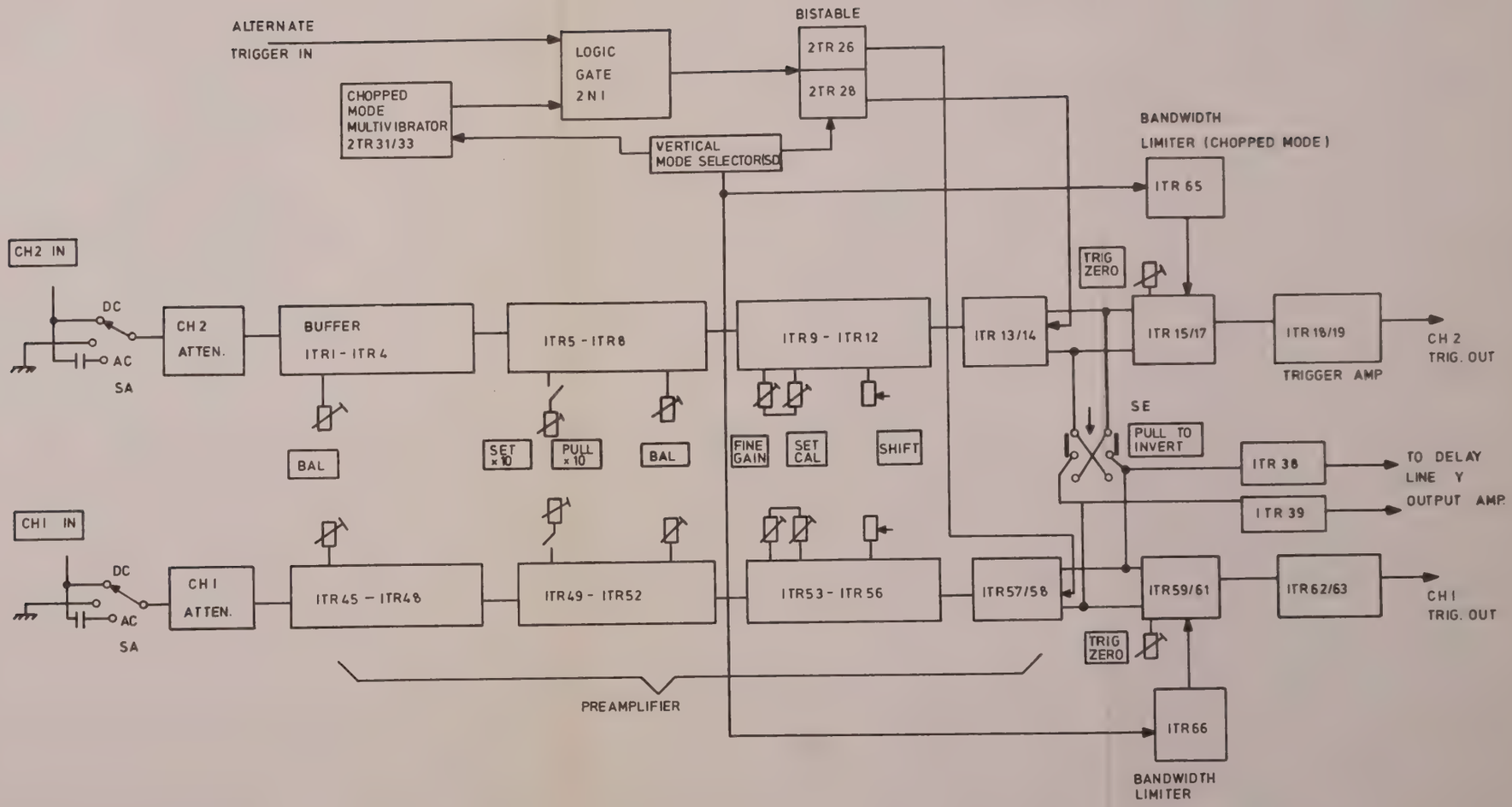
Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R242	DS33756	Mullard MR25	1.2k	2	
R244	DS33754	Mullard MR25	1 k	2	
R246	DS33758	Mullard MR25	1.5k	2	
R247	DS33758	Mullard MR25	1.5k	2	
R248	DS33754	Mullard MR25	1 k	2	
R249	DS33742	Mullard MR25	330	2	
R250	DS33728	Mullard MR25	82	2	
R251	DS33766	Mullard MR25	3.3k	2	
R252	DS33750	Mullard MR25	680	2	
R253	DS33746	Mullard MR25	470	2	
R255	DS33706	Mullard MR25	10	2	
R256	DS33770	Mullard MR25	4.7k	2	
R257	DS33718	Mullard MR25	33	2	
R258	DS33706	Mullard MR25	10	2	
R259	DS33770	Mullard MR25	4.7k	2	
R260	DS33764	Mullard MR25	2.7k	2	
R261	DS33764	Mullard MR25	2.7k	2	
R262	DS33770	Mullard MR25	4.7k	2	
R266	DS33706	Mullard MR25	10	2	
R267	DS33706	Mullard MR25	10	2	
R268	DS33770	Mullard MR25	4.7k	2	
R269	DS33706	Mullard MR25	10	2	
R270	DS33770	Mullard MR25	4.7k	2	
R271	DS33706	Mullard MR25	10	2	
R272	DS33722	Mullard MR25	47	2	
R273	DS33722	Mullard MR25	47	2	
R278	DS33730	Mullard MR25	100	2	
R279	DS33730	Mullard MR25	100	2	
		Resistors (variable)			
R17	FS10300	Plessey	47k	20	$\frac{1}{4}$ W
R32	DS33974	AB Electronic type HC10	220	20	
R37	FS10343	Plessey	100	20	$\frac{1}{4}$ W
R73	DS33849	Morganite	470	20	1/8 W

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R86	DS33866	Erie 80P/2	47		
R105	DS33866	Erie 80P/2	47		
R185	FS10300	Plessey	47 k	20	$\frac{1}{4}$ W
R207	FS10343	Plessey	100	20	$\frac{1}{4}$ W
R243	DS33849	Morganite	470	20	1/8 W
R245	DS33974	AB Electronic, type HC10	220	20	
TR1	BS2938	Texas 2N 5245 (matched pair)			
TR2	BS2938				
TR3 to TR8 (incl.)	BS2835	Texas 2N5179			
TR9	BS2756	Texas TIS48			
TR10					
TR11					
TR12					
TR13	BS2835	Texas 2N5179			
TR14	BS2835	Texas 2N5179			
TR15		Texas BF357K			
TR16	BS2835	Texas 2N5179			
TR17	BS2939	Texas BF357K			
TR18	BS2939	Texas BF357K			
TR19	BS2784	Texas TIS54			
TR38	BS2937	Texas 2N3866			
TR39	BS2937	Texas 2N3866			
TR45	BS2938	Texas 2N 5245 (matched pair)			
TR46	BS2938				
TR47 to TR52 (incl.)	BS2835	Texas 2N5179			
TR53	BS2756	Texas TIS48			
TR54					
TR55					
TR56					

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
TR57	BS2835	Texas 2N5179			
TR58	BS2835	Texas 2N5179			
TR60	BS2835	Texas 2N5179			
TR61	BS2939	Texas BF357K			
TR62	BS2939	Texas BF357K			
TR63	BS2784	Texas TIS54			
TR65	BS2554	Texas TIS50			
TR66	BS2554	Texas TIS50			
		Miscellaneous			
L2,L3	C60698/03	Coil			
X1,X2, X5,X6	GS11168	Ferrite Bead, Mullard type FX1242			

Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
		Capacitors (fixed) µF			
C29	CS30954	Erie 801/K800011	0.01	+80 -20	250 V
C30	CS31020	Erie 831/N1500	47 p	20	500 V
C31	CS31020	Erie 831/N1500	47 p	20	500 V
C32	CS31020	Erie 831/N1500	47 p	20	500 V
C33	CS31020	Erie 831/N1500	47 p	20	500 V
C37	CS30997	Erie 831/K170051	680 p	20	500 V
C38	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C77	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
C78	CS30951	Mullard C280AE/P100K/040	0.1	20	250 V
		Diodes			
D14	BS2624	Mullard BZY88/C8V2			
D15	BS2542	STC 1N4148			
D16	BS2542	STC 1N4148			
D17	BS2542	STC 1N4148			
D18	BS2542	STC 1N4148			
		Resistors (fixed) Ω			
R77	DS7302	Electrosil TR5	10	2	
R112	DS32131	Electrosil TR5	2.2k	2	
R116	DS32359	Electrosil TR5	4.7k	2	
R117	DS32357	Electrosil TR5	1.5k	2	
R118	DS32409	Electrosil TR5	3.9k	2	
R119	DS32440	Electrosil TR5	15k	2	
R121	DS32409	Electrosil TR5	3.9k	2	
R122	DS32440	Electrosil TR5	15k	2	
R123	DS32357	Electrosil TR5	1.5k	2	
R124	DS32359	Electrosil TR5	4.7k	2	
R125	DS32127	Electrosil TR5	470	2	
R126	DS7526	Electrosil TR5	10k	2	
R127	DS32368	Electrosil TR5	6.8k	2	
R128	DS7479	Electrosil TR5	1 k	2	

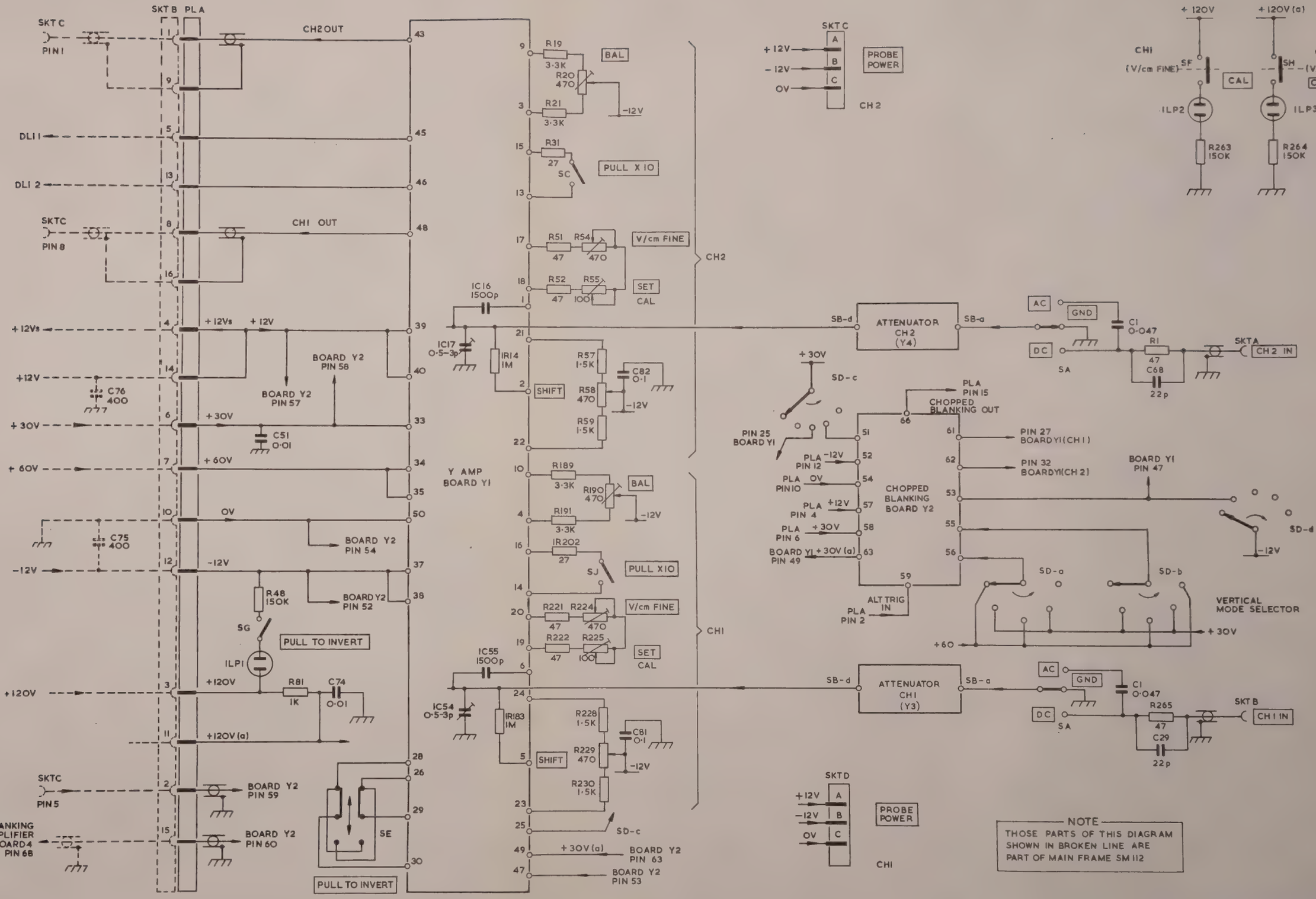
Cct. Ref.	SEL Part No.	Manufacturer/Reference	Value	Tol. ± %	Rating
R129	DS32365	Electrosil TR5	270	2	
R130	DS32385	Electrosil TR5	150	2	
R132	DS32358	Electrosil TR5	680	2	
R133	DS32375	Electrosil TR5	1.8k	2	
R135	DS32357	Electrosil TR5	1.5k	2	
R136	DS32359	Electrosil TR5	4.7k	2	
R137	DS7479	Electrosil TR5	1 k	2	
R277	DS33730	Mullard MR25	100	2	
		Transistors			
TR26	BS2784	Texas TIS54			
TR28	BS2784	Texas TIS54			
TR31	BS2756	Texas TIS48			
TR33	BS2756	Texas TIS48			
		Miscellaneous			
N1	BS2550	Integrated Package, SN7400N			



CM1002

Y-AMPLIFIER MODULE SM 599-SIMPLIFIED BLOCK DIAGRAM

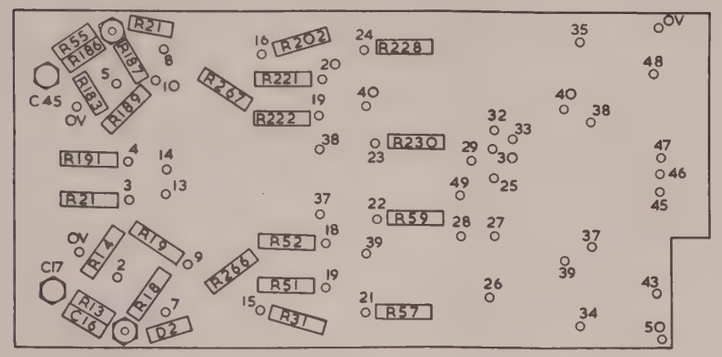
FIG. 4.1.



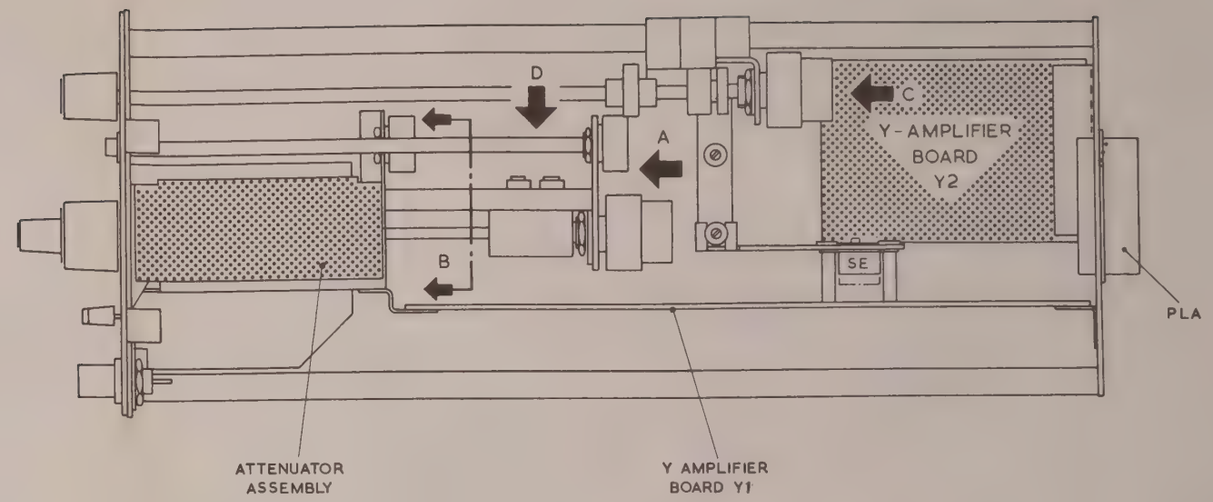
CM1002

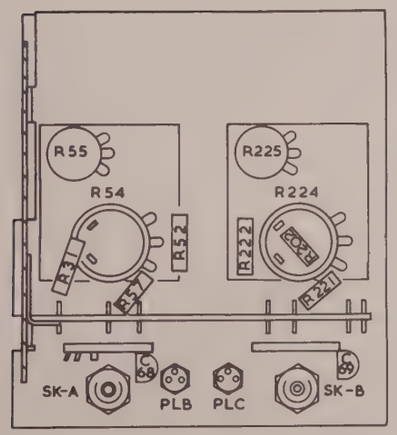
FIG. 4.2. Y-AMPLIFIER MODULE SM 599
BLOCK SCHEMATIC

4-24-B

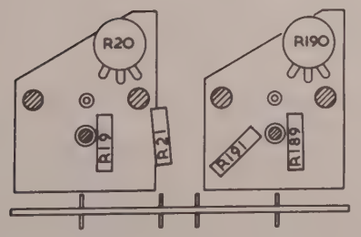


Y - AMPLIFIER BOARD Y1 (VIEW ON ARROW D)

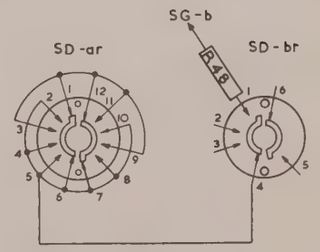


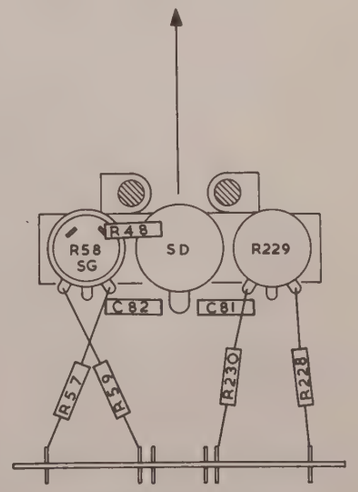


VIEW ON ARROW A

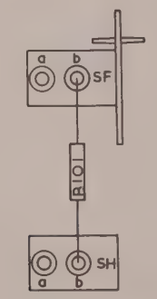


VIEW ON ARROWS B

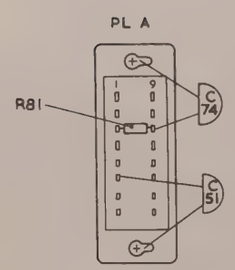




VIEW ON ARROW C



VIEW ON ARROW F



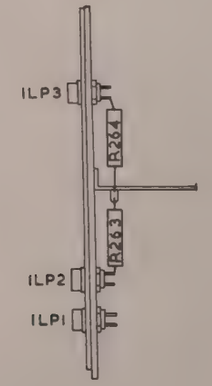
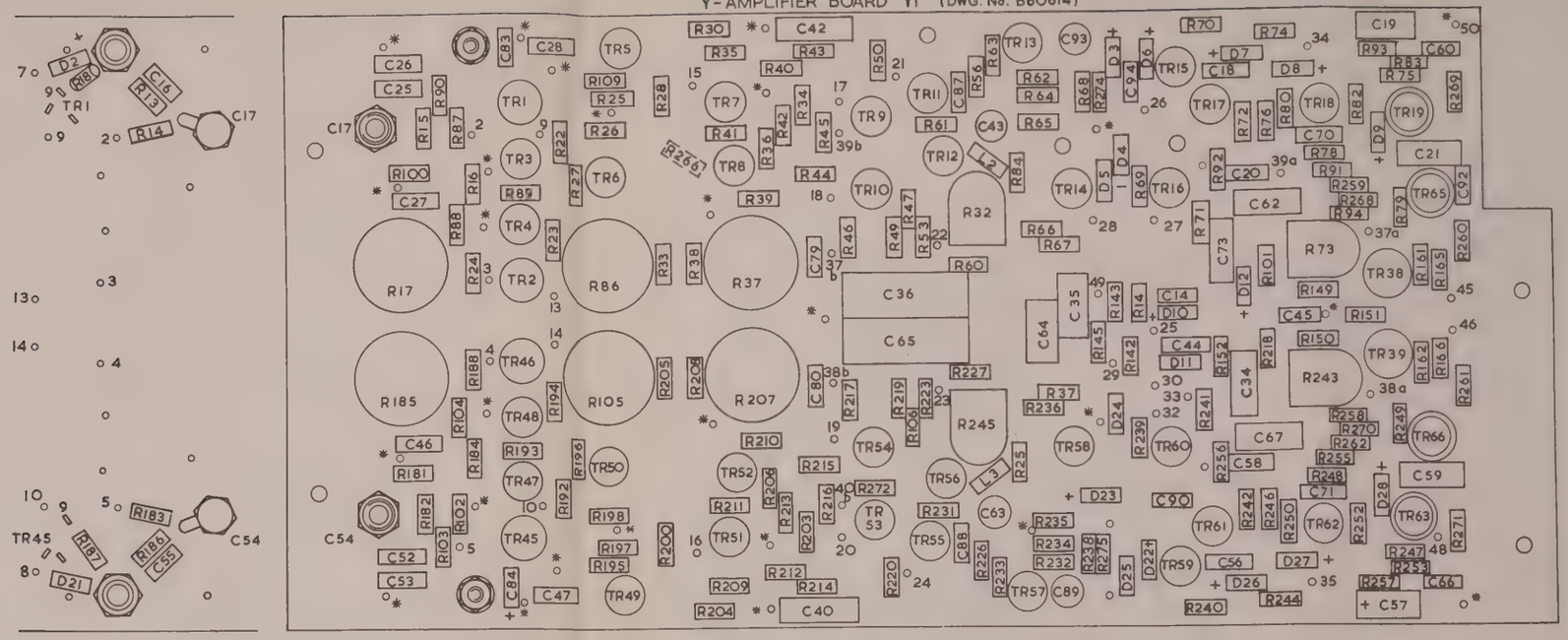


FIG 4.3 Y-AMPLIFIER MODULE SM599
COMPONENT LAYOUT (SHT 1)
(DWG. No. E 60658)

CM1002

Y-AMPLIFIER BOARD Y1 (DWG. No. B60614)


TR1
C17
R17
R86
R37
R185
R105
R207
R245
R32
C36
C65
C54
TR45
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C53
C47
TR49
C40
C42
C26
C25
C27
C28
C83
C84
R30
R35
R40
R43
R44
R39
R60
R227
R210
R215
R272
R212
R214
R209
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R200
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TR48
TR46
TR58
TR60
L2
L3
C57
R1
R2
R3
R4
R5
R6
R7
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R9
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C40

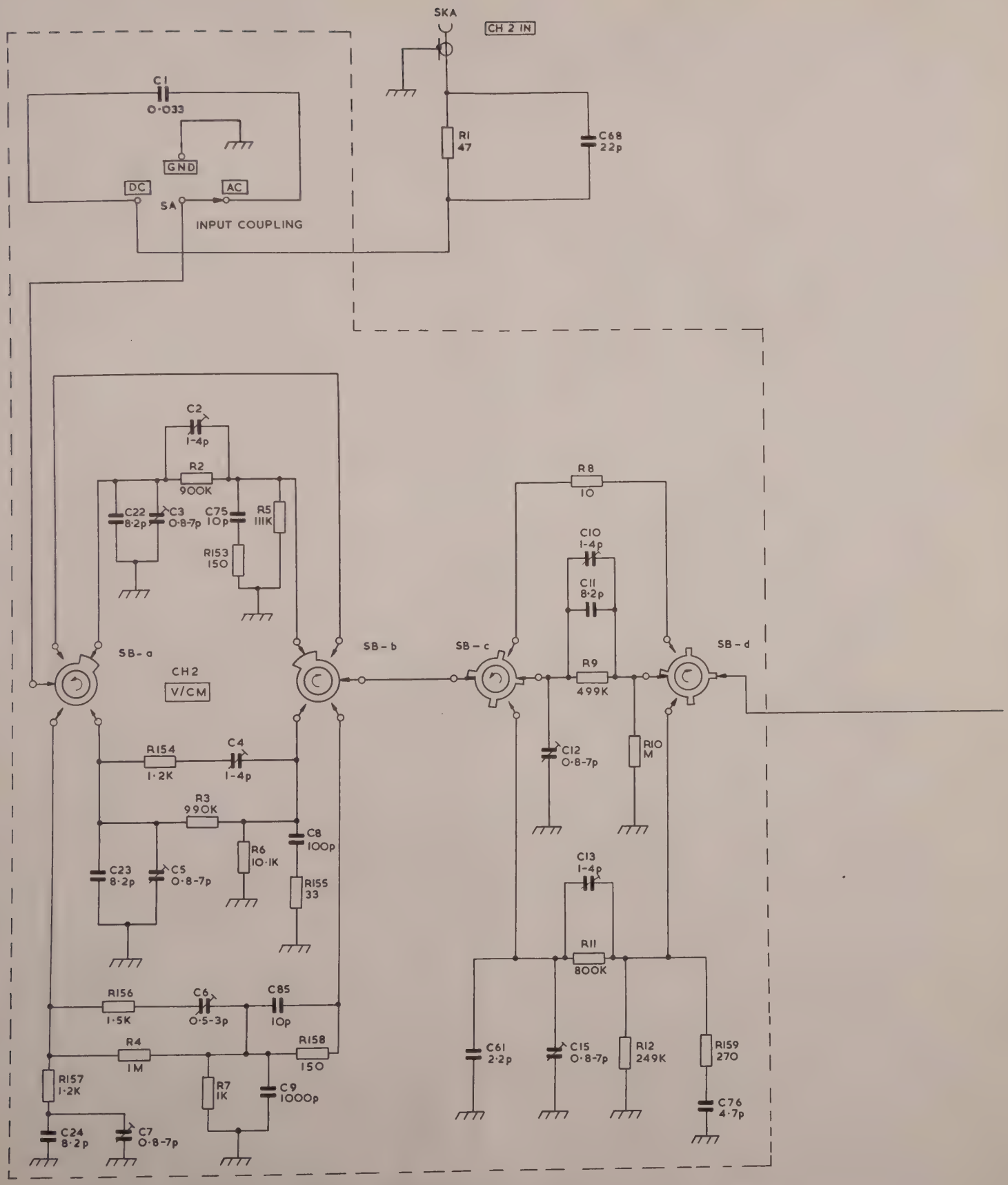
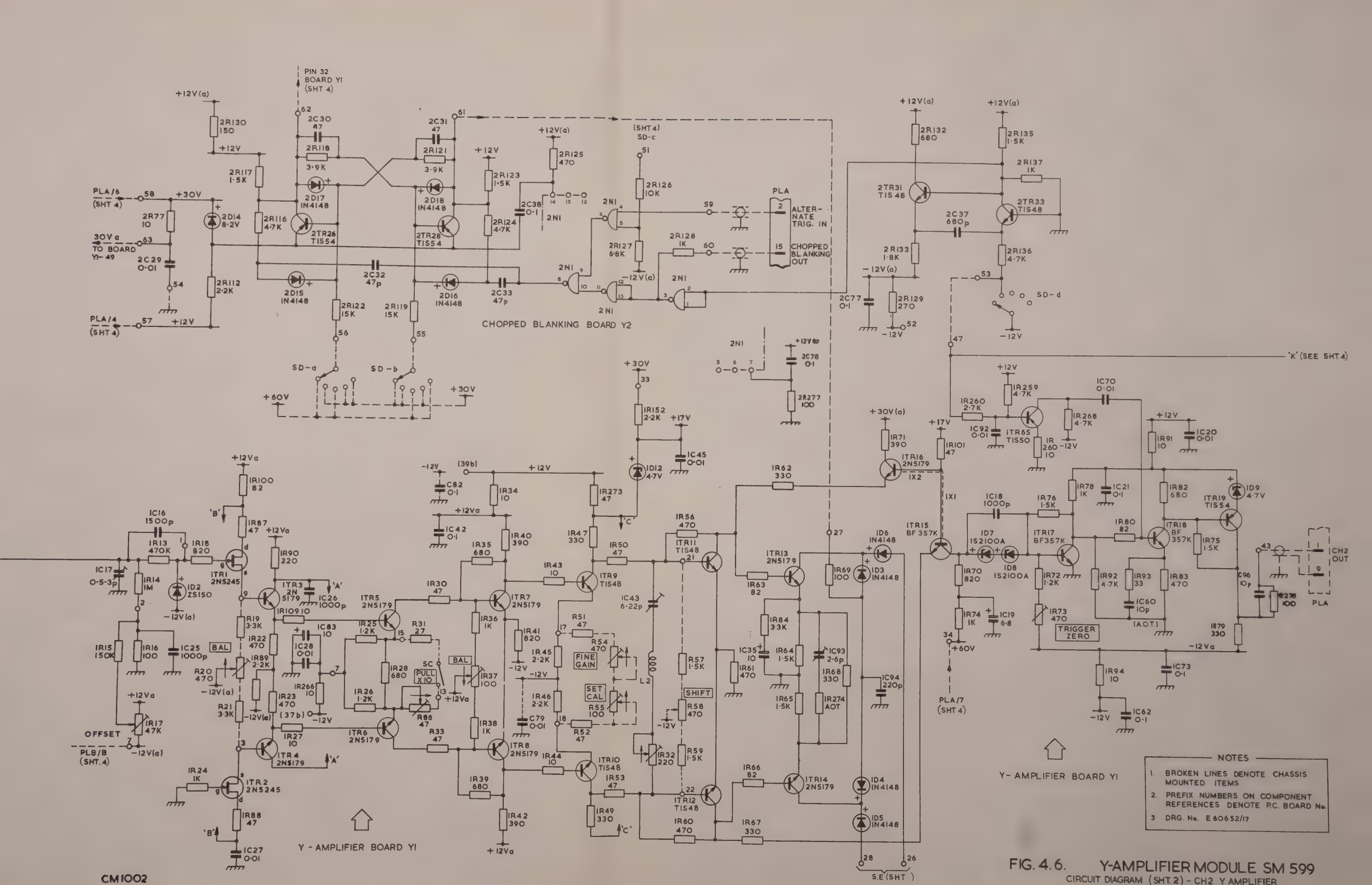


FIG.4.5 Y-AMPLIFIER MODULE SM599 CM1002

CIRCUIT DIAGRAM (SHT I)

CH2 ATTENUATOR UNIT Y4



NOTES

1. BROKEN LINES DENOTE CHASSIS MOUNTED ITEMS
2. PREFIX NUMBERS ON COMPONENT REFERENCES DENOTE P.C. BOARD No.
3. DRG. No. E 60652/17

FIG. 4.6. Y-AMPLIFIER MODULE SM 599
CIRCUIT DIAGRAM (SHT. 2) - CH2 Y AMPLIFIER BOARD YI AND BLANKING BOARD Y2

4-24-D

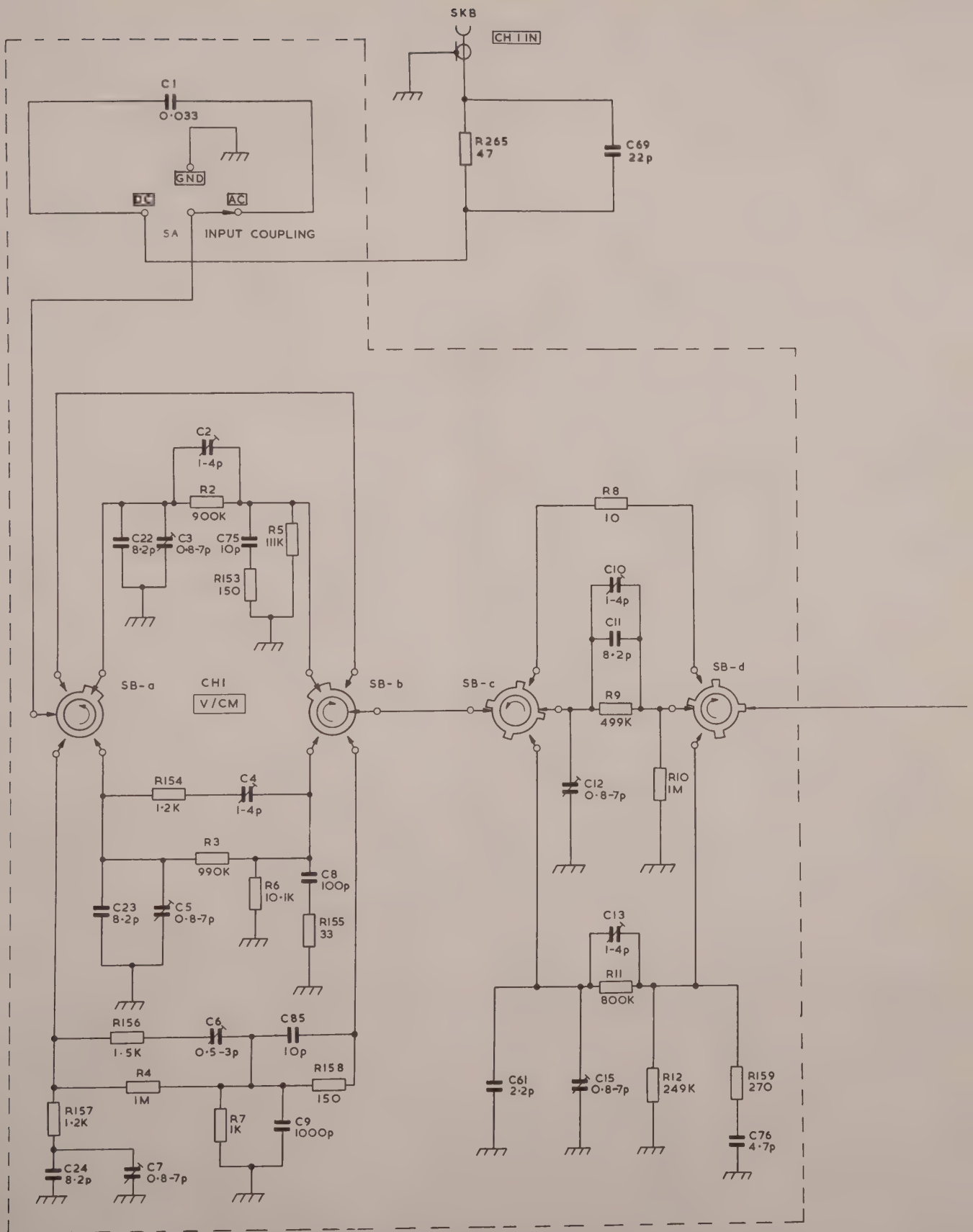


FIG 4.7 Y-AMPLIFIER MODULE SM 599 CM1002

CIRCUIT DIAGRAM (SHT 3)

CH1 ATTENUATOR UNIT Y3

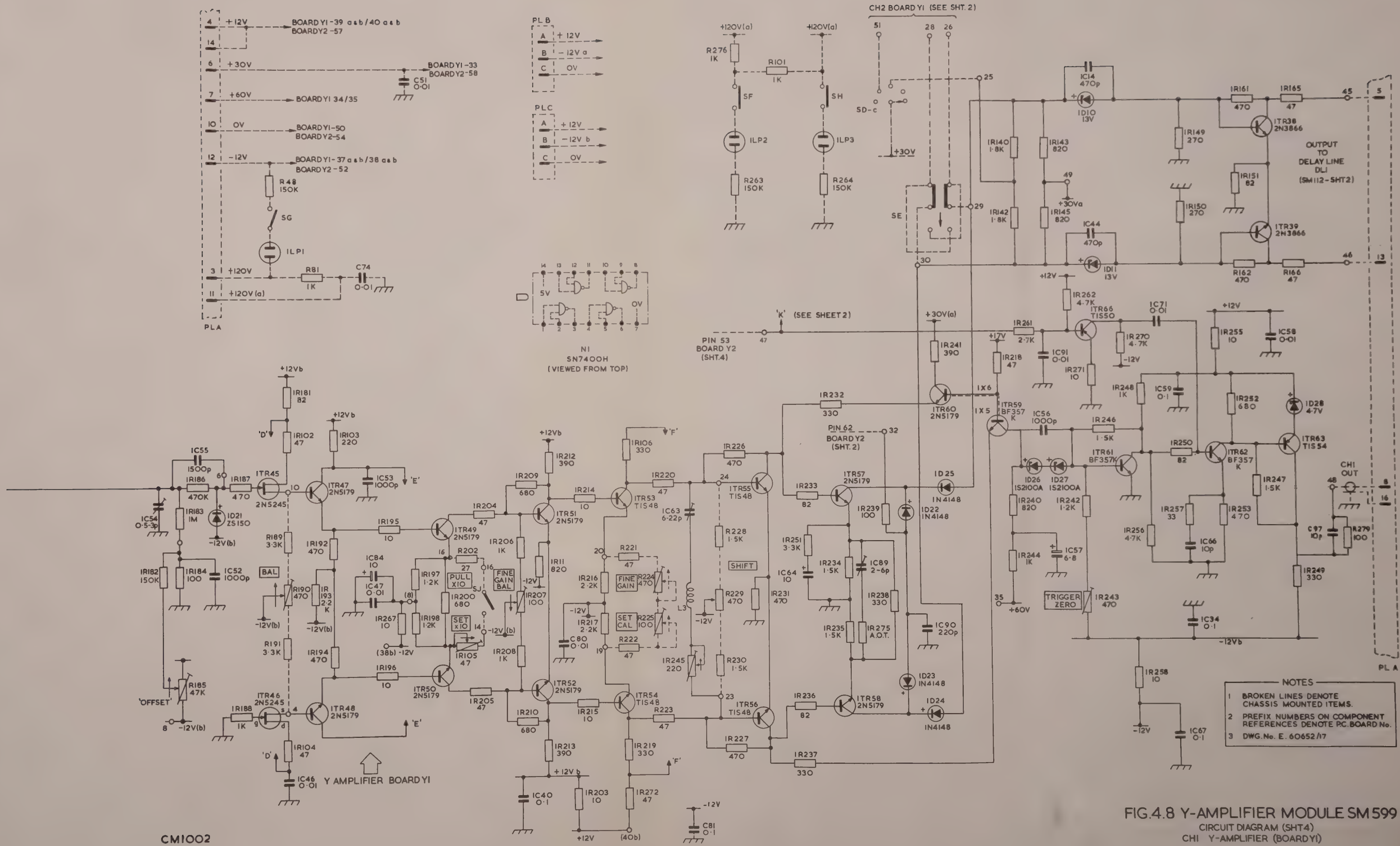


FIG. 4.8 Y-AMPLIFIER MODULE SM 599
CIRCUIT DIAGRAM (SHT 4)
CH1 Y-AMPLIFIER (BOARD Y1)

4-24-

NOTE:

The alignment procedure, detailed in this section, ensures that the oscilloscope, complete with plug-in modules, operates satisfactorily as a system. If an individual unit is suspect, it can be checked separately as detailed in the Alignment Procedures listed under the section of the handbook appropriate to that unit.

5.1 ALIGNMENT PROCEDURE (SM112/SM602/SM599)

1. TEST EQUIPMENT

(a) Fast Squarewave Generator (Tektronix 106 or similar), with lead, 50Ω termination and 10:1 attenuator.

(b) Constant Amplitude Sinewave Generator (Tektronix 191 or similar) with termination.

(c) Oscilloscope Calibrator (Bradley 156 or similar).

2. C.R.T. GEOMETRY

(a) Connect the Constant Amplitude Sinewave Generator, set to 50 kHz, to the CH1 IN, Y-Amplifier Module SM599, connector and adjust the Generator to give a 7.5 cm display, consisting of 100 cycles (or more).

(b) Adjust the 'A Sweep Length' control (1R86) in the SM602 Timebase Module to obtain a sweep length of about 9.5 cm.

(c) Adjust the 'Geom Adjust' control (4R54) to obtain the best overall geometry.

(d) Re-adjust the FOCUS and ASTIG controls to maintain a sharp display throughout this check.

(e) Reset the sweep length to 11 cm.

3. X CALIBRATION (x1/x10)

(a) Set the sweep rate to 10 us/cm and apply 10 μs marker from the Oscilloscope Calibrator (Bradley 156) to the Y-Amplifier Module SM599. Set PULL x 10 to x1 (pushed in) on the main frame.

(b) Adjust the front panel 'Set Cal' control to obtain 1 marker/cm.

(c) Select PULL x 10 on the main frame and check that the setting of 5R156 is correct.

4. × 10 CAL

(a) Apply 10 ns markers from the Oscilloscope Calibrator (Bradley 156) to the Y-Amplifier Module SM599.

(b) Set the sweep rate to 0.5 μs/cm and expansion to x 10.

(c) Adjust 5C84 and 5C59 for a best overall accuracy of ± 5% over the middle 8 cm on both ranges.

(d) Switch to 0.1 μs/cm and check the accuracy. If necessary, re-adjust 5C84 and 5C59 so that the error on the two ranges is minimised. Additional capacitors (5C88 and 5C89) can be fitted if required.

5. ORTHOGONALITY CHECK

(a) Using the Oscilloscope Calibrator, display a 50 kHz sinewave on the 0.1 ms range, and adjust the input to give a 6 cm display.

(b) Align the display, using the COARSE and FINE SHIFT control, so that a positive peak of the sinewave is on the centre graticule line.

(c) Adjust the value of the A.O.T. resistor 5R214 of the main frame so that the two negative peaks on each side of the centre line are symmetrical to within ± 1 mm.

6. CALIBRATOR FREQUENCY

(a) Connect the Oscilloscope Calibrator (Bradley 156) to the CH1 IN connector, set to give a 100 mV squarewave at 1 kHz. Set the channel 1 'V/cm' switch to 0.02 V/cm.

(b) Set the Vertical Mode Selector on SM599 to ALT. Set the A/TIME cm switch on SM602 to 0.1 ms/cm.

(c) Connect the output of the internal calibrator, set to 100 mV, to CH2 IN, with the channel 2 'V/cm' switch set to 0.02 V/cm.

(d) Adjust the 'Cal Freq' control (1R113) so that the two frequencies are the same (to within 1 Hz); i.e. the rate at which one trace drifts with respect to the other is less than 1 cycle per second.

7. CHANNEL 1 (CHANNEL 2) Y CALIBRATION

(a) With the oscilloscope 'set up' as in 6 above, check that the amplitude of both traces is 5 cm.

(b) Adjust the channel 1 and channel 2 CAL controls to achieve this.

8. X BANDWIDTH

(a) Set the SWEEP: AC EXT: DC EXT X input selector to DC EXT and connect the Constant Amplitude Sinewave Generator to the X IN socket.

(b) Adjust the signal input to obtain a display of 5 cm at 50 kHz.

(c) Increase the signal frequency until the displayed signal drops to 3.5 cm. At this point, the signal frequency should be greater than 5.0 MHz.

9. CHANNEL 1 (CHANNEL 2) PULSE RESPONSE

(a) Set the channel 1 (channel 2) Input Coupling Selector to DC. Connect the Fast Squarewave Generator to the CH1 IN (CH2 IN) connector.

(b) Adjust the amplitude of the incoming squarewave to give a display of 5 cm at 100 kHz.

(c) Adjust 6C37, 6C38 and 6C72 on the main frame SM112,and 1C42 (1C63), 1C93 (1C89), 1R32(1R245) on SM599 to obtain a square corner.

(d) Check that the deviation from the final voltage level (the voltage 300 ns after the initial edge) is less than ± 2 mm, or 3 mm total.

10. CHANNEL 1 (CHANNEL 2) BANDWIDTH

(a) Connect the Constant Amplitude Generator, set to 50 kHz, to CH1 IN (CH2 IN) and set the channel 1 (channel 2) Input Coupling selector to DC.

(b) Set the channel 1 (channel 2) V/cm switch to the positions shown in the table below and adjust the output amplitude of the Constant Amplitude Generator to obtain the relevant display size.

CH1 (CH2) V/cm Setting	Display Size (cm)	Minimum Size (cm)
0.01	4	2.8
0.02	4	2.8
0.05	4	2.8
0.1	4	2.8
1	0.4	0.3
10	0.4	0.3

(c) Set the output frequency of the Constant Amplitude Generator to 50 MHz and increase it slowly to 100 MHz, at the same time observing the display. It should not fall below the minimum size as shown in the table above.

11. SPOT LOCATE

(a) With no input selector applied and AUTO de-selected (pushed in) so that no trace is displayed, rotate the X and Y Shift Controls fully clockwise and the BRILL control fully anti-clockwise. Depress SPOT LOCATE and check that the spot is brought back on to the screen.

(b) Repeat this check with the X and Y controls set fully anti-clockwise.

(c) Adjust 3R49 on the main frame SM112 so that the spot has a normal viewing brightness.

12. Y DRIVE (AT 100 MHz)

(a) Connect the Constant Amplitude Generator, set to 50 mV at 100 MHz to CH1 IN. Obtain a display of 3 cm by adjusting the channel 1 V/cm switch and the fine gain control.

(b) Position the displayed waveform by adjusting the channel 1 SHIFT control.

(c) Switch the input signal to 100 mV and check that the displayed waveform is now between 5.8 cm and 6.2 cm.

13. CHANNEL 1 (CHANNEL 2) x10 PULSE RESPONSE

(a) Connect the Squarewave Generator, set to 10 kHz, via the 10:1 attenuator to CH1 IN (CH2 IN).

(b) Set:

(i) Channel 1 (channel 2) Input Coupling to DC.

(ii) Channel 1 (channel 2) V/cm to 0.01 V/cm.

(iii) Channel 1 (channel 2) PULL x10 to x10.

(c) Adjust the output amplitude of the Squarewave Generator to obtain a display of 5 cm. Check that the portion of the squarewave that is at 0 V is flat to within ± 1 mm.

(d) Increase the input frequency slowly to 1 MHz. Check that the flatness is maintained at all frequencies.

14. CHANNEL 1 (CHANNEL 2) x10 BANDWIDTH

(a) Connect the Constant Amplitude Generator, set to 5 mV at 50 kHz, to CH1 IN (CH2 IN).

(b) Set:

(i) Channel 1 (channel 2) Input Coupling to DC.

(ii) Channel 1 (channel 2) V/cm switch to 0.01 V/cm.

(iii) Channel 1 (channel 2) PULL x 10 to x 10.

The resultant display should be 5 cm, ± 1 mm.

(c) Set the input frequency to 18 MHz and increase it slowly until the display size drops to 3.5 cm. Check that the frequency at which this occurs is greater than 33 MHz.

15. CHANNEL 1 (CHANNEL 2) HIGH FREQUENCY TRIGGER

(a) Connect the Constant Amplitude Sinewave Generator, set to 100 MHz to CH1 IN (CH2 IN).

(b) Set the channel 1 (channel 2) V/cm switch to 0.01 V/cm. Adjust the signal input to obtain a centrally-positioned waveform of 1.5 cm.

(c) Set:

(i) Trigger Selector to CH1 (CH2).

(ii) Select AUTO.

(iii) Channel 1 (channel 2) Input Coupling to AC.

(iv) Set X Gain to x 10.

(d) Check that a stable display can be obtained on both positions of the A SLOPE switch, using the A LEVEL and H.F. SYNC controls.

16. CHANNEL 1 (CHANNEL 2) TRIGGER SENSITIVITY

(a) Connect the Constant Amplitude Sinewave Generator, set to 50 kHz to CH1 IN (CH2 IN) and adjust the input signal amplitude for a display of 1.8 cm.

(b) Set the channel 1 (channel 2) V/cm switch to 0.1 V/cm.

(c) Check that, with AUTO de-selected (pushed in), a stable display can be obtained on both positions of the A SLOPE switch, using the A LEVEL control.

WARNING Potentially dangerous voltages of 11 kV and 1.2 kV are present within the oscilloscope in addition to the potentially lethal mains voltage. Care should be exercised during maintenance. Do not remove the covers unless the instrument is disconnected from the a.c. supply.

1. INTRODUCTION

This section contains information on overall system preventive maintenance and troubleshooting techniques.

Access to the sub-assemblies of the oscilloscope can be gained by the removal of the two covers. These are each retained by three captive press-and-turn fasteners.

To aid in locating defective components, reference should also be made to other sections of the manual: the circuit descriptions, circuit diagrams and component location diagrams are particularly helpful in this respect.

Information on the removal of sub-assemblies and on accessibility will be found in the maintenance chapter of the appropriate sub-unit of the oscilloscope.

2. PRELIMINARY CHECKS

If a fault condition is suspected, the following preliminary checks should be made before proceeding with troubleshooting techniques.

Ensure that the controls are correctly set: many apparent fault conditions can be attributed to incorrect control settings. Refer to Vol. 1 (Section 4 , Operation) of this manual, if necessary.

Ensure that calibration is correct: many apparent fault conditions can be attributed to misalignment. These can be corrected by carrying out the relevant alignment procedures detailed under the appropriate sub-sections of the SM112 or under the System Alignment Procedures given in Section 5.

Isolate a fault to circuit level by noting any fault symptons. In many cases, the circuit or card in which a fault has occurred can be identified from these symptoms. For example, an unacceptable quality of display (e.g. excess brilliance, poor focus) indicates that the c.r.t. relevant display controls, or e.h.t. supply may be faulty. The absence of a timebase when switched to delayed timebase mode indicates that the delay circuit on the trigger board is faulty.

Incorrect operation of all, or most circuits indicates a fault in the power supply or supply interconnections. Note that a fault in one supply may cause all outputs of the relevant converter to fall to zero. A large overload will cause a protective fuse to rupture.

3. TROUBLESHOOTING

The following equipment is useful for locating faults in the SM112 oscilloscope.

Multimeter - an a.c. and d.c. multirange voltmeter; sensitivity 2,000 Ω per V; ohmmeter 0 to 20 MΩ
An AVO model 8 is suitable.

Test Oscilloscope - an oscilloscope of similar specification to the SM112 is recommended. A probe should be used to reduce circuit loading.

Transistor Tester - a general-purpose instrument capable of testing the transistors used in the SM112.

As an aid to troubleshooting, waveforms and voltage levels have been indicated at appropriate monitoring points on the circuit diagrams. In addition, pin numbers, voltage rail indications and component identification are given on the silk screening of the printed-circuit cards used throughout the oscilloscope.

Access to sub-assemblies and components is facilitated by the hinged printed-circuit boards and further details of accessibility and replacement of major sub-assemblies is given in the particular sub-unit maintenance section.

3.1 SOLDERING TECHNIQUES

Standard techniques of component renewal should be used but care must be taken to prevent excess heat from damaging the circuit board otherwise the printed wiring may lift away from the base material. When cleaning the area around a solder connection with a flux-remover solvent, be careful not to remove information printed on the board. All solder connections to component associated with either e.h.t. supply should have smooth surfaces. Any protrusion may cause high-voltage arcing in low-pressure or high-humidity environments. A vacuum-type desoldering tool is recommended for removing excess solder.

3.2 WIRING COLOUR CODE

All insulated wire and cables used in the oscilloscope are colour-coded to aid circuit tracing. The low-voltage supply leads are two-coloured as indicated in the following table.

Supply	Colours
+120 V	Red - Green
+60 V	Red - Yellow
+30 V	Red - Orange
+12 V	Red - Brown
+5 V	Red - Blue
0 V	Black
-12 V	Violet - Orange
-18 V	Violet - Brown

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